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[OFFICIAL NOTICE.]

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

The annual meeting of the Association will be held at the Tremont House, Boston, on Wednesday, February 19th, 1879, at 12 o'clock, noon.

Members intending to propose any persons for membership at the annual meeting, are requested to send to the Secretary the names of such persons as soon as possible.

GEORGE B. NEAL, *Secretary.*

BOSTON, Jan. 14th, 1879.

EXHIBITION OF GAS STOVES, APPARATUS, ETC.—The suggestion made in our last issue, that an exhibition should be made in connection with the next meeting of the American Gas Light Association, has met with the approval of many with whom we have conversed on the subject. We shall be happy to publish the views of those interested in this matter, both *pro* and *con*, and trust the matter will be fully discussed through our columns.

CHEAPENING THE PRICE OF GAS.

The constantly increasing demands that are made upon every side, for cheapening the price of gas to the consumer, must inevitably be met sooner or later with a reasonable answer which must show, upon the face of it, and beyond all doubt, either one of two things, viz., a compliance with the demand, or a satisfactory showing that the demand cannot be complied with in justice to the interests of those whose money is invested in the business. For those who cry "monopoly," "extortion," etc., there is no answer that would be satisfactory, for they are, in a majority of cases, merely chief spokesmen for the great army of grumblers who are "never happy unless they are miserable" about something or other, and who would claim that they should be paid for burning gas if it were given to them for nothing. But there is a large and respectable portion of the community who have a very decided opinion that, for some reason, or without reason, the cost of gas to the consumer is too much.

How is this to be met, and how is a reasonable reduction to be made, if the price is too high? This is an important question to the large amount of capital involved in the manufacture of gas in this country.

The first point that we would endeavor to place clearly before the public mind is that the Public itself is often more responsible for the high price of gas than any one else; and this arises from the fact that they have, in many cases, as in the city of New York, not only permitted the multiplication of companies, but have allowed this to be done with the accompanying drawbacks of excessive capital, and large bonded indebtedness. What is the result? A half dozen corporations, with all the presidents, vice-presidents, secretaries, and boards of direction necessary, or customary, for each—together with half a dozen systems of mains, and pipes, and works, etc., with the officers and men necessary to superintend and operate each—and all this, too, when the same work could be done much better, more uniformly, and more cheaply by a single organization, presided over by a competent head, with a single system of works and mains, all operated upon one simple plan of direct responsibility of each and every department to the one head. The city of Brooklyn is in a situation similar, if not worse, than New York. The city of Baltimore has its share of griefs in this respect; while Boston, Philadelphia, and Cincinnati are supplied by single companies. The price of gas in each of the latter cities is lower than in either New York or Brooklyn. This is no new thing; London has been through the sad experience of active competition by opposition companies, and found, from hard experience, that it does not work satisfactorily, and, above all, it does not reduce the price of gas.

The best thing that could happen today would be, if it were possible, to compel the amalgamation of all the companies in this city into one, upon the basis of a cash capital representing a fair value of existing plant for the purposes for which it would be required, not upon a basis of what it has cost, but upon a basis of what it is worth now. It will be answered that innocent stockholders, who have bought stock at very high premiums, and the bondholders (many of whom doubtless have bought at very low figures) would suffer by such wholesale scaling down. This may be true; but most men invest their capital either upon their own deliberate judgment, or upon the theory of "taking the chances." If they err in either case they must abide the result. It may become a question whether it is not better for them to get down at once to a sure, safe footing for the future, even with reduced valuation, than to longer take the chances of having both feet knocked from under them completely. The public certainly have rights, but they also have responsibilities; and if they have neglected the latter they must not complain unreasonably if the former suffer. There are two distinct, yet inseparable, departments in the gas business, viz., making and selling. Those in charge of the former are straining every nerve to cheapen the cost of gas; but, too often, their efforts are hidden from view by the necessities of the often unnecessary expense of the latter. Bondholders who want security, stockholders who want regular and sure dividends, and the consumer who wants the best gas, at the lowest possible fair price, are all interested in this question; and the sooner that they all agree that one gas company is enough for any city, and "make it so," the sooner will each have his wants satisfied.

LECTURE UPON THE ELECTRIC LIGHT.

DELIVERED OCT. 17, 1878, BEFORE THE AMERICAN GAS-LIGHT ASSOCIATION,

By Prof. HENRY MORTON, Ph.D.,

PRES. STEVENS INST., HOBOKEN, N. J.

[Concluded from page 54.]

In addition to the other forms or modifications of magneto-electric machines—by which name I intend to designate all that I have already described, as I do not think that the term dynamo-electric machines, to designate those in which electro-magnets, excited by the machine itself, are used as producers of the "field of force" or magnetic field in which the revolving magnets move, as distinguished from the earlier sort, using permanent magnets or the like, is at all necessary—there are some others which should not be passed over without notice.

In the first place, Mr. Edward Weston, of Newark, is manufacturing a machine resembling exactly in appearance, and, as far as I can see, in all essentials of construction, that which I have already described and shown as Siemens' later form. (See Fig. 27.) With several of these machines I have made numerous trials lately, and find them to run well for as much as ten hours at a time, and to give a higher efficiency in light per horse power than any of the other machines with which I have experimented. This result seems to agree with the general result of experiments made in Europe with the machines of Siemens, and with a general verbal statement which

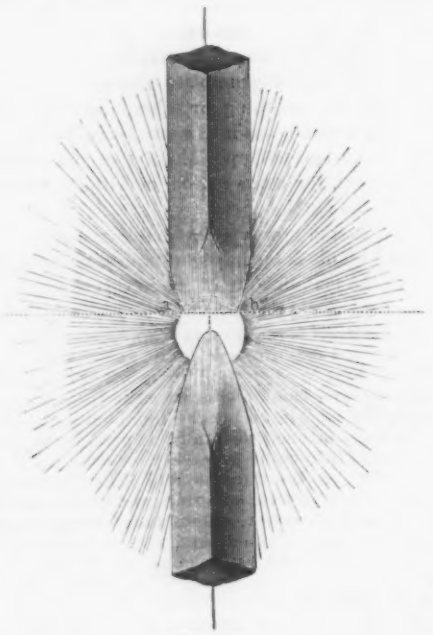

Fig. 40.

was made to me as to the result of experiments at the U. S. Torpedo Station at Newport, R. I., where they have one of these Siemens machines.

There is also a very efficient machine manufactured by Messrs. Arnoux & Hochhausen, of New York. Some of these were used very successfully last summer for lighting the bathing beach at Coney Island, and for lighting several points in New York during the holiday season this winter, and the new State House at Albany during its inauguration.

One of these was kindly loaned to me on the evening of the address here reported, but as it was soon afterward required for use by its manufacturers I have not had an opportunity to make any examination of, or experiments with it. It much resembles the second form of Wilde, or the Farmer machine in general arrangement.

In describing the various forms and modifications of these machines I have not attempted in all cases to follow the chronological order of each step, as this would sometimes have involved the skipping about from one type of machine to another. I will now, therefore, give an abstract of the chronology of the subject, following Dr. Schellen's book as an authority for a part of the list:

1831. Faraday discovered magneto-electric induction.
1832. Pixii made first magneto-electric machine.
1833. Saxton made magneto-electric machine.
1836. Clarke made magneto-electric machine.
1849. Nollet-Van Malderen—Alliance machine.
1852. Holmes introduced electro-magnets.
1857. Siemens introduced peculiar armature.
1864. Pacinotti, the first continuous current machine.
1866. Wilde made his first form of machine.
1866. Siemens & Halske, same principle as Ladd.
1867. Ladd, self-exciting principle.
1867. Wheatstone developed same principle.
1871. Gramme first described his continuous current machine.
1873. Wilde describes his second form.
1875. Siemens describes his machine. (Fig. 27.)
1873. Farmer patented machine like Wilde's second.
1874. Lontin machine, for many circuits.
1878. Gramme's alternating machine.

In considering the practical application of the electric arc as a source of light, it becomes very important to notice with accuracy just what is the chief location of light in the ignited poles, and how this may be affected by various conditions.

Thus, in the first place, if we are using a machine with a current of uniform direction, we will find that the upper or positive pole, as they are generally arranged, soon acquires a cup-shaped form, as shown in Fig. 40, and that the most intensly luminous portion of the carbon is the interior of this positive cup. The edges of this cup will evidently cut off this light from spreading upward for a very considerable angle, while on the other hand all the light from this interior luminous area will pass freely downward. From this it will of course follow that very different results would be obtained if, with such machine and arrangement of the carbons, the lights were measured from below, or on a level, or from above.

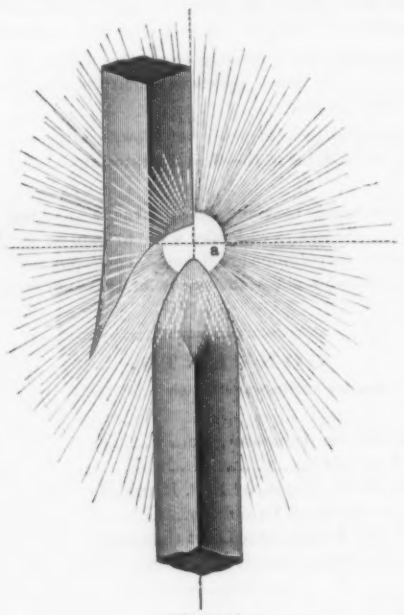

Fig. 41.

If the two carbon points are not placed truly in line with each other, then we have such a state of affairs as is shown in Fig. 41.

Here, evidently, while the light from the hollow positive pole would radiate freely in front, it would be largely cut off behind, and escape only with a medium degree of facility at either side; in fact, measurements made with such arrangement show the following figures:

Representing by 100 the light emited, in a horizontal position, when the points are in line, we have for the various directions, when they are displaced as shown in Fig. 41:—In front, 287; laterally, 116; backward, 38.

In the report of experiments made by a committee of the Franklin Institute (see Journal of that Society, vol. 75, p. 301) I find the record of a similar set of measurements, as follows:

Front	2,218	candles.
Side	578	"
"	578	"
Back	111	"
	3,485÷4=871	

"The light produced by the machine, under the same conditions, except the carbons being adjusted in one vertical line, was 525 candles. This would seem to indicate that nearly 66 per cent. more light was produced by this adjustment of the carbons; but a close study of the conditions sat-

isfied us that such is not the case, and that there is no advantage to be derived from such adjustment, except when the light is intended to be used in one direction only."

This shows us, among other things, how very great a difference of result in candle power may be obtained with the same apparatus, if a difference occurs in the arrangement of the points; and it also explains why an arc which gives a very high candle power when measured, may quite fail to exhibit anything like an equal degree of actual illuminating power when put to some practical use.

Thus, in the case just cited, while the candle power, measured from the front, would be 287, the average for all directions would be only 139, or about one-half as great.

In this connection a certain advantage is found in the use of machines with alternating currents. Here the carbons both burn away alike to pointed ends, and the light is thus much more equally distributed on all sides. (See Fig. 42.)

In most of the machines now in use the current which produces the light is the same which passes around the coils of the stationary magnets, by which the field of force is developed; hence there is the most intimate relation between the machine and the lamp, and any fluctuation in the resistance offered at the latter is at once felt at the machine. To eliminate this source of uncertainty and irregularity, in some experiments which I have lately conducted with various machines I have employed a simple, substantial holder for the carbons, with means of adjustment from time to time by hand. This requires, of course, the frequent attention of an assistant during the experiments, but by this means I have obtained more constant and favorable results, from all the machines tried, than with any of the automatic lamps.

Next to this I have found the Brush lamp to be most satisfactory, when used with its own machine.

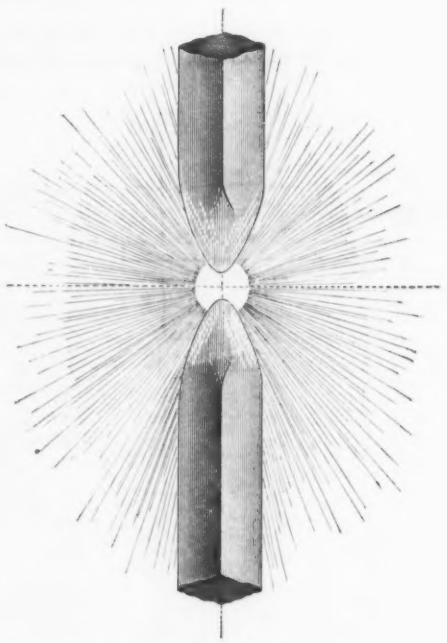

Fig. 42.

As the structure of this lamp is very simple, I will give a description of it here.

This lamp is shown in Figs. 43 and 44, in which *a* is a helix of insulated copper wire, resting upon an insulated plate, *b*, upheld by the metallic post, *c*. Loosely fitted within the helix is the core *d*, partly supported by the adjustable springs *e*. The rod, *f*, passes freely through the centre of the core, *d*, and has as its lower end a clamp for holding the carbon pencil. A washer, *h*, of brass, surrounds the rod, *f*, just below the core, *d*, and has one edge resting on the lifting finger attached to the latter, while the other edge is overhung by the head of an adjustable screw stop, *x*.

The metal post, *c*, is supported and guided by a tubular post, *i*, secured to a suitable base plate. Attached to the lower end of the post, *c*, and passing out through a slot in *i*, is the arm, *y*, supporting an insulated holder for the lower carbon.

If now one conducting wire from the machine be connected to the base plate, and the other to the lower carbon holder, the current of electricity will pass up through the posts, *i* and *c*, through the helix *a*, rod, *f*, and the carbons, *kk*, thus completing the circuit.

The axial magnetism produced in the helix will draw up the core, *d*, and it, by means of the lifting finger, will raise one edge of the washer *h*, which, by its angular impingement against the rod, *f*, clamps and lifts it to a distance controlled by the adjustible stop, *x*, but separating the carbon points far enough to produce the light.

As the carbons burn away, the increased length of the electric arc increases its resistance, and weakens the magnetism of the helix, and therefore the coil, rod, and carbon move downward by the force of gravity until, by the shortening of the arc, the magnetism of the helix is strengthened, and the downward movement arrested. When, however, the downward movement is sufficient to bring the clutch-washer, *h*, to the support, *g*, it will be released from the clamping effect of the lifting finger, and the rod, *f*, will slip through until arrested by the upward movement of the core, due to the increased magnetism of the helix.

The normal position of the clamp-washer is with the edge under the adjustible stop, just touching the support, *g*, the office of the core being to regulate the slipping of the rod through it. If, however, the rod, from any cause, falls too far, it will instantly and automatically be raised again, as at first, and the carbon points thus continued at the proper distance from each other.

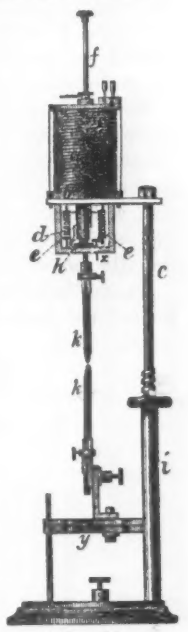

Fig. 43.

In the lamps used in these experiments, the helix was composed of two separate insulated wires wound together, so that, by means of suitable pin contacts, shown at the top of Fig. 10, they could be connected either in

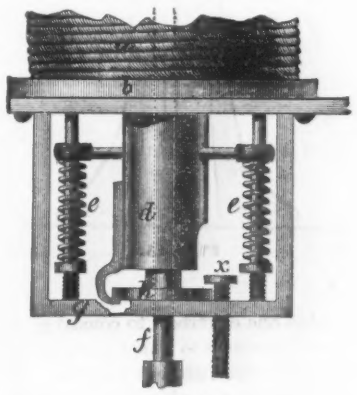

Fig. 44.

couples or end to end, thus varying the intensity of the magnetism of the helix. Thus, in connection with varying the weight to be lifted by the magnetism of the helix, either by loading the core or increasing the upward thrust of the springs, enabled us to adjust the lamp to suit the varying qualities of the currents dealt with.

Several new methods of arranging the carbons, and rendering them more or less adjustable automatically, have been recently suggested or put in practice.

Thus, in *Nature* for Dec. 19th, 1878, I find a plan described by Wilde, which consists in placing two carbon rods beside each other, as in the Jablochkoff candle, but without any insulating material between them. Under these circumstances the author states that the arc will keep to the extremities of the rods, or will run to them if established elsewhere.

To provide against extinction, and secure automatic relighting, one of the holders is hinged so as to allow its carbon to fall against the other unless pulled away by an electro-magnet in circuit. This arrangement is certainly very simple, and free from many of the objections offered in connection with the Jablochkoff candle. It will be seen here, however, that the maximum light will be developed between the two rods, or, in other words, on their respective inner surfaces where it will have the least facility for producing useful effect.

A very curious modification of this candle has been made by Mr. Edward Weston, in which he places a strip of some relatively volatile matter on the backs or outer sides of the parallel carbon rods. The arc then forms across from these parts, and the incandescent vapor assumes much the appearance of a gas flame.

Among the recent forms of lamp described in Dr. Schellen's recent work, "Die Magnet- und Dynamo-Elektrischen Maschinen," are several announced by the Siemens-Halske firm.

In one of these, two carbons inclined towards each other, are allowed

to descend, and thus bring their upper ends together by the withdrawal downwards of a non-conducting interposed rod, whose motion is controlled by an electro-magnet in the circuit.

In another, which, however, looks like a suggestion rather than a practicable machine, the carbons are arranged so that the lower one is constantly vibrating up and down, and the upper one simply rests upon it, except in so far as it is being constantly knocked away by the motion of the lower one, which motion is effected by an electro-magnet in the circuit.

A much more complete apparatus, on the same general principle, we will describe presently.

Among the latest developments in electric lamps may be reckoned the plan of Mr. Werdermann, which may be described as follows:

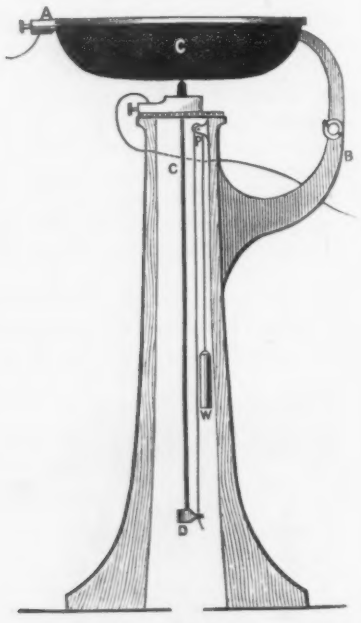

Fig. 45.

Mr. Werdermann makes one electrode to consist of a disc of carbon, tapering in thickness from the centre to the circumference on one side, and flat on the other. The other electrode is a very fine and thin rod of carbon, with one end pointed. The disc is placed horizontally with the rounded side downwards, and the thin rod vertically, and in contact with the disc, the current being supplied *via* the metal collar by which the rod is surrounded near the top. On passing the electricity the fine point of the carbon rod above the collar becomes incandescent, and a very small electric arc is produced between the two carbons. Referring to the diagram (Fig. 45), the upper carbon is shown at c, and the rod carbon at *c*. The former is supported by means of an adjustable jointed bracket B, attached to the wood stand. The rod carbon is guided by the spring collar on the top of the stand, and to which the connection is made, and is supported by the fine cord, running over the pulley P. This cord is attached to the clasp D at the bottom of the rod and to the balance weight W, by which the rod is maintained in constant, practical, though not absolute contact with the disc. Round the upper part of the disc is a metal band A, to which the circuit wire is attached, and the current thus passed on to the next lamps.

"This lamp, (says the *Ironmonger* of Nov. 9), "was tried on October 28, and again on November 6, on the works of the British Telegraph Manufactory (Limited), Euston Road, London, the current being derived from a small Gramme machine of two-horse power. At the commencement two lights were maintained equal to 640 candles, and the light was perfectly steady. Subsequently the current was sent through a row of 20 lamps, the light of each being equal to 40 candles; still the light was steady. Mr. Werdermann asserted his ability to distribute the current from the small machine then at work so as to divide it among 60 lights. In that case the light would inevitably be small; but enough is apparent to prove that, so far as a current will bear division, Mr. Werdermann will be able to utilize it."

It will be noticed that here, as with all other lamps working by incandescence, there is great loss, which increases with the subdivision. A Gramme machine utilizing two-horse power should give, with an ordinary lamp, a light of from 1,000 to 1,500 candles, in place of the 640 here claimed from two lamps, or the 400 candles claimed for ten lamps.

A yet more recent system is that developed, or, we might rather say, now in course of development, by Profs. Elihu Thomson and Edward Houston, of Philadelphia, which they have themselves described as follows:

"As is well known, when an electrical current, which flows through a conductor of considerable length, is suddenly broken, a bright flash, called the extra spark, appears at the point of separation. The extra spark will appear, although the current is not sufficient to sustain an arc of any appreciable length at the point of separation.

"In our system, one or both of the electrodes, which may be the ordinary carbon electrodes, are caused to vibrate to and from each other. The electrodes are placed at such a distance apart that in their motion toward each other they touch, and afterward recede a distance apart, which can be regulated. These motions or vibrations are made to follow one another at such a rate that the effect of the light produced is continuous; for, as is well known, when flashes of light follow one another at a rate greater than 25 to 30 per second, the effect produced is that of a continuous light. The vibratory motions may be communicated to the electrodes by any suitable device, such, for example, as mechanism operated by a coiled spring, a weight, compressed air, etc.; but it is evident that the current itself furnishes the most direct method of obtaining such motion, as by the use of an automatic vibrator, or an electric engine.

"In practice, instead of vibrating both electrodes, we have found it necessary to give motion to but one, and since the negative electrode may be made of such size as to waste very slowly, motion is imparted to it, in preference to the positive. The carbon electrodes may be replaced by those of various subtrances of sufficient conducting power. In this system, when desired, an independent battery circuit is employed to control the extinction and lighting of each lamp.

"The following is a description of one of the forms of electric lamp which we have devised, to be used in connection with our system of electric lighting:

"A flexible bar, *b*, of metal is firmly attached at one of its ends to a pillar, *p*, and bears at its other end an iron armature, *a*, placed opposite the

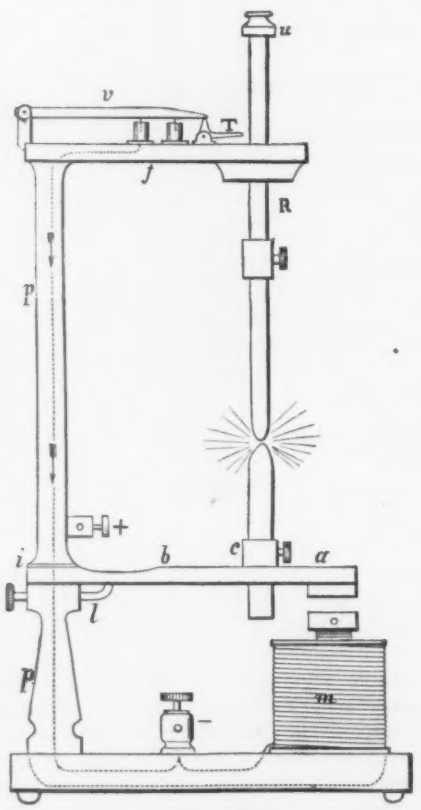

Fig. 46.

adjustable pole-piece of the electro-magnet, *m*. A metal collar, *c*, supports the negative electrode, the positive electrode being supported by an arm, *j*, attached to the pillar, *p*. The pillar, *p*, is divided by insulation at *i* into two sections, the upper one of which conveys the current from the binding post, marked +, to the arm, *j*, and the rod, *r*, supporting the positive electrode.

"The magnet, *m*, is placed as shown by the dotted lines, in the circuit which produces the light. The pillar, *p*, is hollow, and has an insulated conducting wire inclosed, which connects the circuit-closer, *v*, to the binding post, marked —. The current is conveyed to the negative elec-

trode through *b* and the coils of the magnet, *m*. When the electrodes are in contact, the current circulating through *m* renders it magnetic and attracts the armature, *a*, thus separating the electrodes, when, on the weakening of the current, the elasticity of the rod, *b*, again restores the contact. During the movement of the negative electrode, since it is caused to occur many times per second, the positive electrode, though partially free to fall, cannot follow the rapid motions of the negative electrode, and therefore does not rest in permanent contact with it. The slow fall of the positive electrode may be insured either by properly proportioning its weight, or by partly counterpoising it. The positive electrode thus becomes self-feeding.

"The rapidity of movement of the negative carbon may be controlled by means of the rigid bar, *l*, which acts, practically, to shorten and lengthen the part vibrating. In order to obtain an excellent but free contact of the arm, *j*, with the positive electrode, the rod, *r*, made of iron or other suitable metal, passes through a cavity filled with mercury, placed in electrical contact with the arm, *j*. Since the mercury does not wet the metal rod, *r*, or the sides of the opening through which it passes, free movement of the rod is allowed without any escape of the mecury. We believe that this feature could be introduced advantageously into other forms of electric lamps.

"In order to prevent a break from occurring in the circuit when the electrodes are consumed, a button, *v*, is attached to the upper extremity of the rod, *R*, at such a distance that when the carbons are consumed as much as is deemed desirable, it comes into contact with a tripping lever, *t*, which then allows two conducting plugs, attached to the bar, *v*, to fall into their respective mercury cups, attached, respectively, to the positive and negative binding posts by a direct wire. This action practically cuts the lamp out of the circuit."

"PHILADELPHIA, Sept. 19, 1878."

In a later publication (Journal of the Franklin Institute for January, 1879), the same inventors describe a further modification and extension of their system, as follows:

"The following apparatus was devised by the authors for the purpose of obtaining induced reversed currents for use in electric illumination. These currents we use with a vibrating lamp, a description of which has already been published.

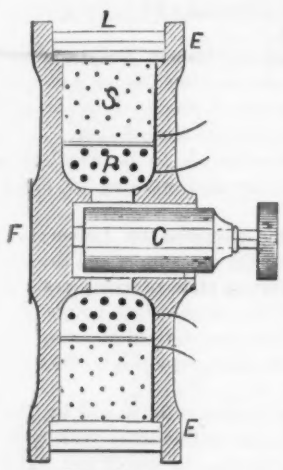

Fig. 47.

"Our method of operation is as follows:—A reversed primary current is caused to induce reversed secondary currents in secondary coils provided therefor. These secondary currents are caused to give vibrations to to carbon electrodes, and thereby at the same time produce a partial arc between them. With sufficient strength of primary current, a considerable number of secondary currents are obtained, each of which is able to operate one of our vibrating lamps.

"The use of a vibrating lamp admits of a wide range in the size of the carbons employed. When a light of very moderate intensity is desired, the carbons are made of very small size, and are placed in a closed glass vessel for protection from the atmosphere. To moderate the brilliancy opalescent glass is used. To obtain the highest efficiency of inductive action from a set of primary coils, the following form of induction of coil was devised:—the primary coil, *P*, surrounding the core, *C*, is provided with a secondary coil, *S*, adjacent to it. The ends *E* and *F* of the bobbin are made of disks of iron concentric with the core, *C*, and slit from centre to circumference. The outer extremities of these disks are connected by wires or sheets of iron, *L*, to one another, forming in this manner an induction coil encased in iron, or one whose core has its north and south extremities magnetically conected. The strength of the current developed in the secondary coil is greatest when the core, *C*, which is movable, is inserted so that both of its extremities are in contact with *E* and *F*. By withdrawing this core, the currents in the secondary coil may be weakened to almost any desired extent. This coil is best adapted to the use of primary currents whose direction is constantly changing. All the wire being completely surrounded by iron, whose direction of magnetic polarization if rapidly changed, the highest inductive effect is thereby produced in the secondary coil.

"The variations in the intensity of the induced currents will, of course, be followed by variations in the intensity of the light emitted by the lamp. The movement of the core may therefore be made to increase or decrease the intensity of the light."

With this notice of the newest, or, as we may say, youngest system of electric lighting, which has its birthday with the new year, I may well conclude this hastily prepared and imperfect notice of this very interesting subject, and if what I have here thrown together may supply at least material for a fuller treatment, or a skeleton on which a completely organized structure may be constructed, I shall have accomplished all that I could hope.

Before concluding this address I should draw attention, in a more direct manner, to something which has been developed indirectly in the course of my remarks; and that is that the loss of efficiency in the electric force as a means of producing light, when it is divided, is not a unique phenomenon, but is exactly paralleled in the case of ordinary combustion.

If gas is burned in very small flames we may get almost no light from it, and, on the other hand, if we burn it in very large flames, the amount of light developed will increase in a much higher ratio than will the amount of gas consumed.

Thus I have here a new burner made by Sugg, of London, with three concentric argand rings which burns 30 feet of gas, and yields a light equal to 196·4 candles. The same amount of the same gas burned in six standard five foot burners yielded a light of 114 candles. Here is a gain of over 70 per cent. in the total light produced, by simply concentrating the combustion in one large flame in place of dividing it into six small ones.

In the case of the ordinary lime-light we have another instance of yet further concentration.

Here, with a consumption of about 7½ feet of gas an hour, in a burner with three jets heating a cylinder of lime from all sides, we obtain a light equal to 260 candles in every direction.

This shows very clearly the illogical character of the comparisons so often made between the concentrated light of the electric arc and the divided light of the ordinary gas burner.

Heretofore electric lights have only been practically developed in their concentrated form, and it certainly has *not* yet been shown that, when divided there will be an enormous loss of efficiency. Gas, on the contrary, has heretofore only been practically used in its divided form, and there can be no doubt that its efficiency is capable of much increase when it is burned in a concentrated manner.

It is here where the actual contest will come in, and the relative success of the two sources of light in each field will depend upon what it will accomplish in that field and not in some other. In other words, we must compare the divided electric lights (say Mr. Edison's, when they become visible) with ordinary burners, and the electric-arc light with the lime-light, or some such concentrated form of gas burning.

THE END.

[From Translation in "Van Nostrand's Magazine."]

The Gas Engines at the Paris Exhibition.

BY M. ARMENGAUD, JR.

ABSTRACT OF THE AUTHOR'S ADDRESS AT THE CONFERENCE DU TROCADERO.

The attention of most of those in attendance at this Conference has been drawn at the Exposition to certain machines, which, in their general appearance and mode of working, resemble steam engines. But upon approaching them it is readily seen that the similarity is only apparent; the movements of these motors are accompanied by a series of slight detonations, and a near inspection reveals the fact that attached to each is a perforated chamber, within which burns a flame which seems to give life to the machine. These are the gas motors. The motive power is derived from illuminating gas, not from steam.

It is proposed to present to the conference some explanations of the structure and mode of working of the different engines of this class exhibited at the Champ de Mars, and to consider the possible future achievements of these engines if they continue the progress so clearly made manifest by this exposition.

Such a progress would hardly seem to possess sufficient interest to hold the attention of an audience not composed exclusively of engineers. But it is proposed to relieve the subject of its technical character as far as possible, and present the more general form of discussion. The task is rendered easy by the very happy circumstance that in the working of a gas engine we find a summary of the most beautiful applications of scientific principles.

A gas motor possesses the essential organs of the steam engine; the cylinder which receives the gaseous fluid; the piston which, by aid of a rod and crank, transmits the pressure to the shaft; the fly-wheel which regulates the motion; and the pulleys and belts by which the power is conveyed to the machines to be driven.

The gaseous fluid is a mixture of gas and air, in such proportions as is

most susceptible of explosion when brought in contact with an ignited body. The mixture is exploded by the little flame before mentioned, and the products of the combustion, suddenly dilated by the heat, urge the piston and develop the motive power. The gas on burning combines with the oxygen of the atmosphere; that is to say, the carbon is converted into carbon dioxide, and the hydrogen into water. This change is completed only under the condition that the volume of air is sufficient to afford the proper amount of oxygen; the gas requires about seven times its volume of air. The combustion may be completed in the open air or in a closed space. An example of the first kind is afforded by the burners in metallurgical works. The gas and air arrive separately and by small quantities at a time, so that their union is affected without sensible noise. If, however, the air and gas are mixed in advance and ignited in a closed space, then the cumbustion takes place throughout the whole mass at once; a strong detonation and a probable rupture of the envelope immediately follow. Of such kind are the explosions which result from the careless leaving a gas pipe open in a closed room. The gas, diffusing throughout the room, becomes capable of exploding as soon as the volume of gas is equal to one-twentieth the volume of the air.

The flame is not absolutely necessary to effect the explosion, as an electric spark will serve the same purpose; but it is necessary to establish a point of intense heat somewhere in the mixture.

The effects of gas explosions are explained, as are those of powder explosions, by the enormous increase of volume of the combustion products at the instant of burning.

In the case of the mixture most suitable for explosion, seven parts of air to one of gas, the explosion develops 10,180 units of heat for each kilogram of gas used, or 6,000 units for each cubic meter. The heat is instantly communicated to the gaseous products, raising the temperature about 2,700 degrees.

Now, as gas dilates to the extent of 1-273 of its volume for each degree of rise of temperature, it follows that a heat of 2,700 degrees would expand the mixture to nearly ten times its normal volume.

When a mixture of twelve parts of air to one of gas is exploded in the cylinder of a gas engine, the heat developed by the explosion is abont 1,400 degrees, and the gases develop a tension of six atmospheres. The effect on the piston is the same as would be produced by the introduction of a gas or vapor under a pressure of six atmospheres, and exactly as in the case of such vapor do these gaseous products of explosion, by their expansion, urge the piston of the engine. In this way is the work of gas engines developed.

Gas engines have many points of resemblance to steam and hot air engines. In one as in the others it is the expansion of a gaseous fluid which originates the work of the engine. Whatever the nature of the fluid, its elastic force is employed to move the piston. This fluid, then, is only an intermediate agent employed to convey heat, and giving up a portion during the process of transportation. The heat which disappears is converted into mechanical work, and is the source of power in the motor. This correlation of heat and motion is one of the most beautiful conceptions of modern science.

The essential differences in the various kinds of motors above mentioned reside in the different modes of communicating heat to the intermediate gaseous body.

In steam engines heat is first employed in converting water into steam, and then in augmenting the heat of the steam. The vaporization is effected outside of the cylinder—that is to say, in the boiler, and some time before the steam acts upon the piston. In hot air engines the heat which dilates the air is equally apart from the cylinder.

It is quite otherwise with gas motors, for in these the heat is developed within the cylinder and in the midst of the gaseous mass, and only at the moment that power is wanted. As there is no storing up of the heat, nor any transportation of it, these causes of loss are avoided.

The advantages of such a mode of production and utilization of heat are apparent. While in the steam engine the time of firing up, of evaporating the water, and of raising the steam to a proper temperature is necessarily consumed, in the gas engine it is only required to admit the gaseous mixture by a single turn of the stop-cock. Furthermore, *the gas engine consumes fuel only while it is doing work.* In this quality it possesses a *great advantage over other heat engines* in those branches of industry which require only an intermittent application of power.

Although the conception of the employment of a detonating mixture as a source of power is a simple one, the practical realization is not without complexities. The heat developed by the explosion of the mixed gases in the old Lenoir gas engine was communicated to the products of the explosion and the excess of air too suddenly; the expansion was too violent, and in no way like the motive force in steam or hot air engines. Its ill effects were only mitigated by admitting air in large excess before the explosion. Such sudden shocks were not in keeping with the regular motion required of a motor.

Furthermore, the heat tended to escape as rapidly as it was generated, by conduction through the sides of the cylinder. A testing of the cylinder resulted, which was only partly avoided by a current of water on the outside.

The heat developed in the cylinder of the gas engine tends to disappear in two ways: one by conduction through the sides of the cylinder, and subsequent radiation, and the other by the expansion of the gaseous products left after combustion. The first of these is useless; the other useful. Utility demands that the first should be counteracted and the second developed. One step toward the accomplishment of this object is attained by allowing a very rapid expansion of the gases in the cylinder. Gas engines ought therefore to work with high velocity.

Loss of heat is also occasioned by the escape from the cylinder of the mixture at a high temperature. It is clearly necessary, furthermore, to develop all the heat of which the original combustible gas is susceptible. This is attained by its complete combustion, which depends upon the method of mixing with air and igniting.

Such are the requirements for good service in gas engines. We propose to explain to what extent they are fulfilled in the gas motors of the Exposition, first glancing at the history of previous experiments in this direction.

As with all other great inventions, many nations claim the honor of producing the first gas engine. A very complete and impartial history of the subject has been written by M. H. Tresca, who presides over this conference. From this history are largely drawn the notes here presented.

The application of gun-powder as a motor preceded the use of both steam and gas. Before thinking of the employment of steam, Papin constructed an engine to be driven by cannon power, following suggestions made by Huyghens in 1678, and Hautefeuille in 1680. In the machine described by Papin in 1688, and which contains a piston and valve, he did not seek to utilize in a direct manner the expansion of the gas, but only the force, which is the direct result of this expansion. It was upon the same principle that he devised a little later a steam engine.

John Barber, in 1791, was the first who proposed to produce a motive force by burning hydrogen or other inflammable gas. But his engine was without a piston, and was only urged by the force of a jet leading from the vessel in which the explosion was produced.

Then came the inventions of Thomas Mead and Robert Street, in 1794, who employed—one the gas resulting from the combustion of some substance in a fire, and the other the volatile vapor produced by dropping petroleum or terebenthine or similar substances into the cylinder.

To Philip Lebon, who invented gas illumination, is to be ascribed the honor of devising the principles of construction and working of the gas engine.

It is most remarkable that in the machine described by Lebon in his patent of 1799, there are two pumps one for the air supply and the other for the inflammable gas. These imply a certain state of compression before the explosion, an idea which is one of the most salient points of the improved motors of the Exhibition. Lebon also devised the use of the electric spark for igniting the mixture, a method employed in the Lenoir engine.

Experiments by Rivaz in 1807, by Samuel Brown in 1823, and by Talbot in 1840, only need be mentioned here. A patent in this latter year by MM. Demichelis and Monnier describes for the first time the use of gas. It was generated in an apparatus which formed part of the engine. In some patents coal gas was replaced by vapor from petroleum and by other volatile liquids. Other inventors proposed to use air which had been carburetted by passing through naphtha, benzine or similar liquids.

Omitting the names of many experimenters of this period, Hugon (1858), and Lenoir (1859), may be mentioned as being entitled to the honor of first applying gas motors to industrial purposes. These two forms were known and enjoyed celebrity in 1867. Several Hugon engines figured in the French section in the Exposition of that year.

It is unnecessary to describe here the details of these machines. It is sufficient to say that they utilized directly the expansion of the gases. The piston at each stroke admitted on one side the mixture which was ignited at the middle of the stroke, and expelled on the opposite side the products of the combustion. The essential differences of the two systems was in the distribution and mode of igniting the gases. Hugon employed a gas flame for this latter purpose, and Lenoir an electric spark from a Rhumkorff coil.

The Hugon engine is supplied with an apparatus for carefully adjusting the quantities of air and gas supplied to the cylinder; but it does not appear that any advantage in the way of economy of consumption of gas has been gained over that afforded by the Lenoir engine.

Next to these forms came the engine of Otto and Langen of Cologne. This is a vertical engine, the former were horizontal. The principle of ac-

tion of the Otto engine is different inasmuch as it utilizes the effect of expansion in an indifferent manner only.

The piston rod urges the shaft only in an intermittent manner; it is geared to a pinion on the shaft which engages the shaft by means of a friction pulley only on the down stroke. On the up stroke the piston is driven violently by the expansive force of the gases till the pressure of the mixed products equals the atmospheric pressure, and is carried beyond this point by acquired momentum. It stops only when the work of the atmospheric resistance has absorbed the accumulated work in the piston. There results a rarefaction under the piston, so the down stroke is urged by atmospheric pressure aided by the weight of the piston. This descent is the effective stroke of the engine, for it is only then that the piston rod is connected to the driving shaft.

This method of employing the effects of the explosion only indirectly has yielded good results economically; affording one horse power for a consumption of one cubic meter of gas per hour, in place of 2.7m as in the Lenoir and Hugon engines. But the noise of the engine as in the former cases is quite unendurable, and has led to its rejection.

Claude Segre, an Italian engineer, and M. Schmitz, the engineer of the Paris gas company, have made a thorough study of these systems of motors, and with the result of the following classification into two general divisions.

1st. That system in which the expansive force of the gases acts directly upon the piston and, through this, upon the other moving parts, as in the Lenoir and Hugon engines, and

2. That in which the force of the explosion urges the piston (which for the moment is free) until a partial vacuum is created below it, when the atmospheric pressure is brought to act, and at return stroke producing the effective work. This includes the Otto and Laugen engine.

Sometimes both plans of action are exhibited in the same engine. An example of this kind is afforded by the Gilles motor, a specimen of which was exhibited in the English section of the Exposition. This belongs to an improved form of which there are three kinds, represented respectively by: 1st, the motor of Mr. Otto, of Cologne; 2d, the engine of Louis Simon of Nottingham; and 3d, the engine of M. Bisschof.

In the engines of Messrs. Otto and Simon, the mixture of gas and air is compressed before explosion, so that the initial pressure at the moment of ignition is twelve atmospheres; double that obtained in the Hugon and Lenoir engines where the mixtures before explosion were of a tension of atmospheric pressure only. Furthermore, in these new forms the ignition of the gases is gradual.

The two ideas of previous compression of the mixed gases and a gradual combustion, instead of a violent explosion, distinguish the improved engines from the old forms.

We will describe these systems more particularly:

The Otto engine resembles externally a single acting steam engine. It has a single horizontal cylinder, open at one end and closed at the other, with a head furnished on the inner side with a conical cavity. The piston is connected by a crank with the shaft of the fly-wheel. Behind the cylinder is the supply chamber, which is furnished with a direct connection with the main shaft. The pistons at the in-stroke does not reach the end of the cylinder, but leaves a space equal to about two fifths of the capacity of the cylinder. This is the compression chamber.

The cylinder serves the double purpose of compression pump and working cylinder, which is perhaps not the least of the characteristics of the new system.

The complete cycle of motions in the Otto engine is accomplished only by two complete revolutions of the working shaft, or four strokes of the piston. It comprehends the four following phases, viz:

1st. The piston makes an up-stroke drawing in the explosive mixture of gas and air:

2d. The inlet cock closes and the piston returns, compressing the gaseous mixture;

3d. At the moment the down-stroke is completed, and while the tension of the gases is somewhat above two atmospheres, the mixture is inflamed, and the consequent expansion causes the piston to make an up-stroke:

4th. The piston returns driving out the expanded and cooled gases.

Thus of four strokes of the piston, only one (the third) conveys motive force to the shaft.

The second consumes power; the other two have no appreciable effect.

Such a method of working calls for a heavy fly-wheel, the accumulated work of which accomplishes the compression of the gases.

A special regulator to the engine intercepts the supply of gas and delays the ignition whenever the velocity becomes too great. Furthermore, the engine works without noise—a great advantage over the Otto and Langen motor.

The effective working power of the engine is of course the difference between that afforded by the expansion of the gases and that absorbed by the compression. The indicator diagrams show a regular curve of pressures very different from the line of abrupt changes exhibited by the Lenoir engine.

The regular decrease of pressure in the Otto engine is due to the method of burning the mixed gases. The combustion is retarded so that the heat developed is absorbed by the gases, at a rate that is better in accord with the motion of the piston.

M. Otto has accomplished this by his method of mixing and admitting his gases. He employs two different mixtures; one of fifteen parts air to one of illuminating gas, which he calls his "feebly explosive mixture;" the other of seven parts air to one of gas, is called his "strongly explosive mixture."

During the working of the engine, and at the moment when the gases are about to be ignited, the contents of the cylinder are: products of the preceding explosion, atmospheric air, hydrogen, and hydro-carbon gases. These are not uniformly diffused, but owing to the position and action of the valves, the most combustible portion is at the bottom of the cylinder at the point of ignition, and the combustibility probably decreases quite regularly from the bottom of the cylinder to the piston.

The result of this condition is a *prolonged* explosion, and the force of expansion is less of the nature of a shock than in the previous engines.

In order to insure combustion with proper rapidity, a jet of "strongly explosive mixture" is made to traverse the mass at the critical moment.

Such is the principle of action of M. Otto's engine. It satisfies the theoretic conditions indicated above. That it employs heat to good advantage is indicated by the small loss shown by the outside cooling of the cylinder. Experiments prove a heating of 35 litres of water per hour for each horse-power, the water being raised from 10° to 86°C.

This is 2,520 units of heat; as 6,000 units are generated by the combustion, the loss is 42 per cent. The loss in the Lenoir engine, according to M. Tresca, was 85 per cent.

The principle of compression was employed in the hot air engines. Ericsson and Franchot both applied it in their motors. In these engines it has a double use; at first to diminish the heating which is pernicious to these engines, and then also a reduction of the size of the parts of the engine for a given power is accomplished.

But if the previous compression is so advantageous in the working of the engine, it may be asked is it equally advantageous to its practical performance? In other words, is the advantage gained an adequate return for the work expended in compressing the gas?

Calculation shows that the same quantity of gas not compressed would yield a greater amount total of motive force, but on the other hand the loss by compression is compensated by a better utilization of the heat generated.

By means of the measurement of the lost heat mentioned above it is found that the Otto engine is nearly three times as effective as the Lenoir or Hugon engine.

It is not surprising therefore that in place of 2·7 metres of gas consumed for each horse-power per hour, the Otto engine yields the same power by the consumption of one cubic metre or probably less in large engines.

The principle of action of the Simon engine is essentially the same as the Otto, but there are some notable differences in the details. The compression is performed in a separate cylinder; upon the admission to the working cylinder the mixture is ignited by a gas flame kept constantly burning. The cylinders are vertical and the two piston rods connect with the same horizontal shaft.

The admission of the explosive mixture and the escape of the products of combustion are managed by valves worked by cams on the working shaft. The mixed gases are admitted in a series of small charges and inflamed successively, thereby insuring a gradual expansion. This method affords also a good economy of heat, a very small quantity of water sufficing to keep the cylinder cool.

The regular variations of tention in the working cylinder were sufficiently shown by the indicator diagrams taken during the exhibition. The curve exhibits some slight sudden variations upon the opening of the inlet valve, then it rises to full pressure and remains for a time constant; then falls nearly to atmospheric pressure at the opening of the escape valve. It is claimed that the consumption of gas is less than one cubic metre per horse power per hour.

One of the peculiarities of M. Simon's plan is the use of steam in connection with his gaseous mixture.

It was an idea of the earlier inventors—M. Hugon among the first—to reduce the excessive heat in the cylinder by a jet of water. But it proved difficult to regulate. M. Simon introduces a jet of steam from a boiler heated by the escaping gases. The water supplied to the boiler is first used to cool the working cylinder. Thus the heat which tends to escape is utilized. Furthermore, the steam in the cylinder tends to absorb with useful effect any excess of heat resulting from the explosion, and also acts to some extent as a lubricant to the piston.

M. Simon claims to have obtained results superior, in point of economy of working, to those obtained by the Otto engine.

The Bisschof engine belongs to the class that utilizs the effects of an explosion to drive the piston. The cylinder is vertical and the piston rod connects with the shaft in such manner as to utilize in the fullest degree the effect of expansion. No water is employed for cooling the cylinder; the result is secured by constructing the cylinder with projecting ribs or flanges so as to expose an abundance of radiating surface.

Engines of small size only have thus far been constructed on Bisschof's system. Most of those made have been designed to run sewing machines with a capacity of one-fifteenth to one-half a horse power. The working of these costs, in Paris, two cents an hour for the former, and only five cents for the latter size.

It was the intention of the inventor to solve the question of furnishing a light motor for domestic use. Its advantages are:

1st. It employs no water.

2d. It possesses great stability without specially prepared foundations.

3d. It utilizes as completely as possible the force of the explosion, by the long stroke of the piston.

4th. All shock is avoided by cushioning the air on the down stroke.

The cylinder is heated by a gas burner a few minutes before starting, otherwise the moisture, resulting from the explosion, might deposit within the cylinder and in the absence of oil rust in it. By starting with the cylinder heated this is avoided.

The Ravel motor could not be shown at the Exposition under conditions that would permit its working.

In this engine, which is called by the inventor *moteur a centre de gravite variable*, the explosion of the mixture lifts a heavy piston. The cylinder is furnished with trunnions which turn in bearings and which being prolonged form the axis of the machine. An explosion chamber, either attached to the end of the cylinder or independent of it, receives the explosive mixture where it is ignited by a gas-flame; the heavy piston is thrown upward; the reaction forces the cylinder to oscillate like a pendulum, and as at each fall of the piston a new explosion gives it a new impulse, the oscillations are continued. The time of fall of the piston is made to agree with the vibration of the cylinder, by varying the resistances to the rise of the piston. No experiments have been tried with this engine which would justify the expression of a definite judgment in regard to its efficiency, though the principle of its action does not forbid the expectation of a good degree of economy.

Having thus reviewed the gas engines of the late Exposition, we arrive readily at the conclusion that the progress in this direction since 1867 has been very great. The improvement is evidently not alone owing to the ingenious mechanical devices, but also to a closer study of the utilization of heat. The science of thermodynamics teaches us that heat and motion are effects of the same cause; they are equivolent. All loss of heat is loss of work or energy, and in case of the motors just considered, the heat produced is a measure of the gas employed and the cost of the motive power.

The expense of working, therefore, depends upon the proper utilization of the heat. This expense has of late been much reduced, the consumption of 2½ cubic meters in the Lenoir engine yielding the same useful effect as is obtained by one cubic meter in the Otto engine.

The motors of Otto and Simon exhibit superior qualities in the way of economical working. If at present the Bisschof engine does not possess the same advantage, it still merits a favorable appreciation for having furnished, in so complete a manner, a solution of the the problem of supplying a motor of one-man power.

What is more reasonable than to expect of our gas companies a supply of heat and force as well as light? Many light industries which require machinery might then be pursued at the home of the artisan.

In thus eulogizing gas engines, it is not to be concluded that they are recommended to replace steam engines. There is a use for all. Gas motors will compete with small steam engines, or with water engines; and in places where neither gas nor water power is easily obtained, hot air engines may properly be preferred.

In concluding this glance at recent progress, the wish may be expressed that this advance towards the amelioration of human toil shall not be checked, but that the end may soon be reached in which all of man's intelligence shall be demanded, and almost nothing of his muscular strength. Although we are yet far from this desideratum this consoling thought remains to us when from this point of view we compare our epoch with antiquity. In place of the sad inscription "Sale of Slaves" in the market place, we read on modern sign-boards "Motive-power to sell."

REMARKS BY THE PRESIDENT, M. TRESCA.

I ask permission to call attention a little more particularly to two points in the discussion which has been so well presented by M. Armengaud.

If I estimate correctly the old engines of Hugon or Lenoir consuming 2,500 litres per horse-power per hour, would cost, at the present price o gas in Paris, 75 centimes per hour, as one horse power is 75 kilogrammeter per second, it follows that power at the rate of one kilogrammeter per second costs one centime per hour. If we reckon the work of a man turning a crank at five kilogrammeters, it results from the above estimate that the cost of this labor performed by the gas engines is five centimes per hour.

The later improvements however yield such results that one man power per hour is afforded for two and a half centimes.

I add these remarks because the gas engine thus modified is a motor in which heat is transformed into work in the best possible manner, and I have far more confidence in the future success of these modifications of the gas motor than I have in the hot air engines, which require so much more space and do not conform readily to the theoretic conditions of the problem.

[From the "Gas Trade Circular and Review."]

Street-Lighting by the Phoenix Gas-Light Company.

The Phœnix Gas Company are at work in the Waterloo Road, permission for the purpose having been freely given by the Lambeth Vestry. The scene of operations is from the South Western Railway Station to Waterloo Bridge. At the point where the main road is intersected by the traffic which crosses over between Stamford-street and the York road, there are two "sanctuaries." Here there are two of Mr. Sugg's gas lamps, each giving the light of 200 candles. Four lamps of 100 candles each occupy the four corners furnished by the junction of Stamford Street and the York road with the main thoroughfare. By this provision of six powerful lights an important centre of traffic is most effectively illuminated. Near the foot of Waterloo Bridge are four lamps equal to 50 candles each. Those portions of the Waterloo Road lying between the bridge and the railway station which are not thus illuminated are provided with lamps of the ordinary kind, so far as concerns the form of the burner, but the quantity of gas consumed per hour has been raised from five feet to six feet. These lamps are forty-eight in number, and are placed only one-third the distance apart compared with the lamps previously existing at that spot. The space between the lamps has thus been reduced from sixty yards to twenty yards, and the number increased from sixteen to forty-eight. The light from the new lamps is that of fifteen candles, as against twelve from the old burners in addition to which the light is assisted by the use of opal reflectors. The posts are shorter by two feet than those usually employed. The idea has been to give along the length of the road, for a distance of five hundred yards, an illustration of good lighting by ordinary lamps properly designed and sufficiently near together, accompanied by a concentration of light at certain spots where special brilliancy is a practical advantage. Mr. Woodall, chief-engineer of the company, furnishes an estimate of the cost as follows:

Cost of lanterns, posts, burners, fixing, etc., £120; interest on first cost, at 10 per cent., £12; lighting, cleaning, repairing, etc., at 15s. per lamp per annum, £40 10s.; gas, 48 burners at six feet per hour, eight at 15, and two at 35; total, 478 feet per hour, which, multiplied by 4,200. the number of hours during which lamps are alight in the year, gives 2,007.600 cubic feet, at 3s. 4d. per 1,000, £334 12s.; total, £387, representing the cost of gas used in lighting a broad road 500 yards long, well and thoroughly for a year, or 1s. 10d. per hour. It is suggested that this lavish light could be diminished after midnight. The company are aware that to raise the cost of lighting a section of road from 5½ to 17d. per hour is, of course, to add materially to the lighting rate of a district; but they point out that it must be remembered that only in the more public roads is such brilliant lighting necessary. Comparing the cost of their light and of the electric light, the company aver that the electric light on the Holborn Viaduct was fixed at distances apart of about 60 yards, those on the embankment 50 yards. The lighting of the viaduct is distinctly faulty, because the intervening spaces are too great, and are in comparative darkness. Taking 50 yards as the proper distance apart, it would require 20 electric lights to do the work involved in the present experiments in Waterloo Road. The carbons for these alone are said to cost 5d. an hour per lamp, and this one item alone will amount to £1,750 per annum. But taking 1s. per light per hour as a fair price for the electric light, the cost would be £4,200 per annum as against £387, the cost of gas-lighting. Such is the assertion of the company, and we mention it without comment. It is to be hoped that the result of these competitive experiments will be to afford the public the benefit of the cheapest and best artificial illumination.

THE GAS TRADE CIRCULAR AND REVIEW.—This journal, published in London, reaches us in a much improved form, and under the management of Mr. Charles W. Hastings, who also publishes the "Gas and Water Companies Directory. It fills a space before unoccupied by giving, in a condensed form, the items of interest to those engaged in the trades connected with gas making, as well as to the gas makers themselves, and also a general discussion of gas matters.

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TERMS

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MONDAY, FEBRUARY 17, 1879.

Annual Report of the Superintendent of Lamps, City of Boston, for Year 1878.

LAMP DEPARTMENT, Jan. 10, 1879.

To the City Council:

GENTLEMEN—The Annual Report of this department for the past municipal year is herewith respectfully submitted, in accordance with the ordinance of the city requiring it to be presented on or before the 10th day of January.

It contains a table showing in detail the expenses of the past municipal year, a table showing the comparative expenditures for twelve years, a table showing the number of lamps and comparative increase during the same period, together with such general information as may be of interest.

The increase in the number of the public lamps the past year has been considerably in excess of the year previous.

A large proportion of the new lamps which have been located are in the suburban section of the city, where oil is used.

Constant and pressing petitions have been made for the location of new lamps in the outlying districts, and for the lighting of rear passage-ways in the older section of the city (where they are demanded as police necessities), which have been generally regarded by the committee as reasonable requests.

During the year a large number of old wooden posts and small lamp supplies have been discontinued, and iron posts and new and large gas supplies put in, adding much to the general good condition of the department.

There still remain standing about sixty wooden posts, which have been in use for a number of years, and which should be speedily replaced with iron.

The replacing of the old and worn-out small gas supplies by new and large pipes must be continued to prevent leakage and consequent danger to persons and property.

ELECTRIC LIGHT.

The project of lighting by electricity has, within the last year, attracted considerable attention.

In England and France experiments have been, and are now, making to ascertain if a better and less expensive light can be produced than that of gas.

In this city nearly every one has had an opportunity of seeing the light as produced by the electric machines at the exhibition of the Mechanics' Charitable Association, and, since the close of the exhibition, at one of the large stores on Washington street.

Inquiry has been made to ascertain if this method of illumination could, with economy, be introduced in this city, in the public streets or squares.

The largest electric machine manufactured by the "Brush Light Company," which seems to have found favor with the public, is capable of supplying but sixteen lights, each equal to that lately shown on the outside of the Mechanics' Charitable Association building, on Park square, and on the outside of the building on Washington square, corner of Harvard street.

Should sixteen lights, which this machine is capable of supplying, be located on Charles, Beacon, Arlington, Boylston streets, and within the Public Garden, it is propable that the Garden and adjacent streets would be quite as well lighted as at present.

The cost of the electric machine, boiler, engine, lamps, posts, wire, etc., and setting, would not be less than $6,000, not taking into account the building which it would be necessary to erect for the machinery.

The cost of maintaining the lamps, when the machinery, etc., is in place, is estimated at $2,700 annually, without allowing anything for depreciation or interest on the plant.

As yet the carbon points are not made of sufficient length to produce a continuous light over seven or eight hours; a difficulty which may, however, be overcome.

The cost of gas, lighting and care of the lamps now lighting the locality indicated, is $2,750.

The estimated cost of the plant is $3,000, and the depreciation cannot exceed $50 per annum.

It will be noticed that the present mode of lighting is considerably less expensive than the proposed electric light, although the square might be better lighted, and sufficiently so to justify the trial.

There is no other place in this city where anything like as many gas lamps could be discontinued by this same number of electric lights, and consequently in any other locality the comparison would be much less favorable to electric lighting.

PUBLIC PARKS.

As stated in the last annual report of the department, there are public lamps now located on the Common and squares of the city to the number of 250.

The location of these lamps has been going on gradually for many years, under charge of, and at a very considerable expense to, this department, at the request of numerous citizens and the police department, as the public safety seemed to demand, and it is fair to presume that with the laying out of the new park a greatly increased demand will be made for public lighting.

Quite a large number of these lamps are removed during the winter season, when the parks are little frequented.

Within the past year but two or three lamps have been added to the number upon the parks, but a petition for lamps upon the Public Garden has received the favorable consideration of the Committee on Common and Squares, and referred to the Committee on Lamps.

This committee, while recognizing the convenience of additional light upon the Garden, did not consider the expenditure absolutely necessary at this time, especially in view of the investigations and inquiries relative to lighting this ground by electricity.

The annual cost to this department of maintenance of the lamps now located on the Common and squares of the city amounts to nearly $10,000, which should properly be charged to the department having the public parks in charge, as is the case in other large cities.

The attention of the government is again called to the subject of

CHANDELIER POSTS, OR CLUSTER LAMPS.

This method of lighting up some of the important points of night-travel, which, like Scollay's square, Park square, and Post-office square, are very broad and unsafe for the pedestrian, has been adopted with favorable results on some of the squares in the city of New York, and in many of the larger cities of Europe, and is worthy of serious consideration.

When erected in the centre of a circle of eight to ten feet in diameter, they will not only afford the necessary light for the street, but the circle in which they may be placed will afford a safe standing place from teams, when alighting from horse-cars or crossing the street.

They may, with small expense, be made ornamental as well as useful in our city.

GAS FOR PUBLIC LIGHTING.

During the year 1875 a contract was made with the Brookline Gas Light Company for supplying gas for the public lamps of Brighton and that portion of the town of Brookline annexed to Boston.

The following is a copy of the contract made as above:

"This memoradum of agreement, made this fifteenth day of February, in the year eighteen hundred and seventy-five, by and between the city of Boston of the one part and the Brookline Gas Light Company, a corporation duly established by law of the Commonwealth of Massachusetts, of the second part,

"Witnesseth that,—

"I. The said Brookline Gas Light Company agrees to furnish all the gas required for lighing the public lamps within that part of the city of Boston mentioned in their charter of incorporation, on each and every night of the term of this contract, as hereinafter agreed, in such manner and between such hours as the Superintendent of Lamps of said city shall direct; to put down service-pipes for public lamps in said district where new pipes are required, and to keep in repair the pipes in use in said district, and to use for such new pipes and repairs only wrought-iron pipes, not less than one inch in diameter, and wrought or malleable iron couplings and bends or elbows; such service-pipes to have a regular fall toward the street mains.

And said Gas Light Company further agrees to furnish regulator burners for all the public lamps in said district, and to fit the same to said lamps, said burners to be of the pattern known as the "Sugg burner," and to cost not over one dollar and twenty-five cents each,—the cost of said burners and fitting the same to be borne equally by said parties; and in the months of September and October, during this contract, to remove and clean all the street burners in said district without interfering with the regular burning thereof, and also to furnish to the said city such quantity of whiskey as may be necessary to clear the pipes from obstructions, not to exceed, however, seventy gallons in any one year.

"II. The city of Boston agrees to pay to said Gas Light Company, for gas furnished as aforesaid, at the rate of three dollars per thousand cubic feet of actual burning, each burner consuming four feet per hour, free from all taxation, and to make payment thereof monthly.

"Said city also agrees to employ lighters to light, clean, and take care of all the public lamps in said district, who shall light and extinguish them punctually, according to printed tables to be furnished by said Superintendent; shall make written returns to said Superintendent and said Company, on Monday of each week, of the number of lamps lighted each night, and the time of beginning to light and beginning to extinguish the same, and shall keep the burners and portions of the pipe above ground, within their respective rounds, free from frost and other obstructions, and give immediate notice to said Company and said Superintendent of any obstructions below ground, and of any leakage of gas. Any neglect of duty by a lamplighter shall be considered sufficient ground for his immediate dismissal.

"Said city also agrees to repay to said Gas Light Company the actual reasonable expense incurred by them for the labor and materials required for putting

down service-pipes and keeping the pipes in use in repair, and also to repay to said Company one half the cost of the regulator burners and of fitting the same; provided the cost of said burners shall not exceed one dollar and twenty-five cents each, and also one-half of the actual reasonable expense of removing and cleaning said burners in September and October as aforesaid.

"III. It is further agreed that either party hereto, with the consent of the other party, may from time to time, at is own expense, remove and test any of the burners in use in the public lamps in said district, without interfering with the regular burning of said lamps; and all new burners shall be tested before being used, such test to be made in the presence of some representative of each party hereto; and all burners which vary more than one-tenth of a foot from the designated standard shall be replaced by said Gas Light Company, the cost thereof to be borne equally by said Company and said city.

"IV. It is expressly agreed that the slot of all lava-tipped burners shall be cleaned by the use of a suitable brush, and that no metallic cleaner shall be used upon them, and no lighter shall be permitted to open the regulator of any such burner, for any purpose whatever.

"V. This agreement shall continue in force until the fifteenth day of February, A. D. eighteen hundred and seventy-six, and thereafter until a new agreement shall be made, or either of said parties shall notify the other of its wish to terminate the same."

The above contract embraces the conditions and points now covered by the several agreements made with other companies made since 1876, except as to prices for gas, which are varied from time to time, the present prices of which will be found below.

PRICE PAID FOR GAS FOR PUBLIC LAMPS.

City proper,	$1.90	per thousand	cubic feet.
South Boston,	2 25	"	"
East Boston,	2.25	"	"
Roxbury,	2.25	"	"
Dorchester,	2.75	"	"
Brookline,	2.75	"	"
Brighton,	2.75	"	"
West Roxbury,	2.75	"	"
Charlestown,	2.25	"	"

In the summer of 1876, at the suggestion of the then Committee on Lamps, the following reductions were made in the price of gas for the public lamps:

City proper,	from	$2.08⅓	per thousand to	$2.00
Roxbury,	"	2.50	"	2.45
W. Roxbury,	"	3.00	"	2 90
Brookline,	"	3 00	"	2.90
Brighton,	"	3.00	"	2 90
Charlestown,	"	2 50	"	2.40

Early in the year 1877, at the suggestion of the committee, the following reductions in rates were made:

In Roxbury,	from	$2.45	per thousand to	$2.40
South Boston,	"	2.50	"	2.40
East Boston,	"	2.50	"	2.40
Dorchester,	"	3.00	"	2.90

The result of the above reduction was a saving to the city of over $16,000 per annum

Early in the year 1878 the committee deemed it proper that a further reduction in price should be made, and the following reductions were agreed upon by the several gas companies:

City proper,	from	$2.00	per thousand to	$1.90
South Boston,	"	2.40	"	2.25
East Boston,	"	2.40	"	2.25
Roxbury,	"	2.40	"	2.25
Dorchester,	"	2 90	"	2.75
Brookline,	"	2.90	"	2.75
Brighton,	"	2.90	"	2.75
W. Roxbury,	"	2.90	"	2.75
Charlestown,	"	2.40	"	2.25

These last reductions aggregate about $25,000 per annum.

HOURS OF BURNING.

The public lamps are burned every night throughout the year—a total of 3,828, hours each.

GAS BURNERS.

The burners in use are known as Tuft's Regulators, by which the consumption is fixed at four feet per hour.

GAS LANTERNS.

As the gas lanterns made for the city are made of copper, and all made for the past six years have the Schmedlin & Driscoll patent mode of placing the names of the streets in them, and an arrangement for placing the numbers securely in the lanterns, which was the invention of the superintendent of the department.

This patent method of placing the street signs appears to be the best in use, more especially since the adoption of the acid or sand-blast process of producing the signs on colored glass, which makes the letters durable.

The placing of the numbers in the lanterns is being generally extended over the city, and gives great satisfaction to the public, being a great convenience both by day and night.

The advantage of this style of gas lantern for use in this city will be fully appreciated by the knowledge of the fact that nearly one-half of the public lamps stand on the corners of or opposite the ends of streets or places, and have the names of the streets or places upon them.

EMPLOYEES.

The number of men employed is 133, as follows:

One superintendent, one clerk, 127 lighters, and 4 repairers.

No deputy superintendents or supernumerary men are employed.

The men (106 in number) who light and clean the gas lamps are paid at the following rates:

City proper	41 men.
South Boston	8 "
East Boston	5 "
Charlestown	7 "

one and one-half cents per lamp per night; while in

Roxbury	20 men.
Dorchester	13 "
Brookline	1 "
Brighton	5 "
West Roxbury	6 "

are paid at the rate of $1.50 per day.

COMPENSATION OF THE EMPLOYED.

The salary of the superintendent is now $2,800, having been reduced in 1877 from $3,300.

The salary of the clerk is $800, having been reduced in 1877 from $840.

The lighters who light the gas lamps by the piece have had their pay reduced during the past year from 1¾ to 1½ cents per lamp, while those employed by the day have been reduced from $1.67 per day to $1.50 per day.

The men employed to light oil lamps are paid at the rate of 3 cents per lamp per night.

Nearly all the men who light the oil lamps use horses and wagons with which to perform their duties, for which the city pays no extra compensation.

The men who light the oil and fluid lamps are 21 in number, as follows:

City proper	1 man.
South Boston	4 men.
East Boston	2 "
Roxbury	1 man.
Dorchester	5 men.
West Roxbury	6 "
Brighton	2 "

LAMPLIGHTERS' DUTIES, ETC.

The lamps are lighted by the use of the torch.

The duty of these men is to light and put out the lamps in their charge promptly at the time designated; to keep the lanterns clean at all times, and report at this office in writing, promptly, for immediate repair, every defect, either of the lanterns or fixtures; to keep the fixtures properly cleaned and oiled the burners in perfect order, and the pipes clear from water and frost. In case of gas leaks, they are required to report immediately, in writing, both at this office and to the office of the gas company; they are also required to make a statement in writing on each Monday morning, of all the duty performed the previous week.

These men, after performing the duty, have a considerable portion of the time remaining, and are allowed to have other employment, provided it shall not in any way interfere with any duty which may be required of them in this department.

This privilege is very generally used by the employees, and in this way the city is enabled to procure an intelligent and reliable class of men, at a much less cost than it could expect to do otherwise.

All men employed to light both gas and fluid lamps are supplied with the necessary ladders, hooks, cans, etc., by the city.

The men employed during the year have been generally prompt and faithful, and cases of discharge for neglect of duty have been very rare.

BROKEN LANTERNS.

The number of lanterns which have been reported by the police as broken the past year was	232
By the lamplighters	6,606
Taken out by repairers without report	749
Total	7,587
Against—	
Broken in 1875	8,268
" 1876	7,444
" 1877	7,527

All repairs of the lanterns are done by the department at its workshop on Albany street.

At this shop there are four men permanently employed, and two who work at piece-work or the painting of lanterns.

All the cost of men permanently employed, piece-work, repainting lanterns, painting posts and brackets, carting of lanterns, oil, and posts, stock used in repairing, horse-keeping, etc., are included in the item in the schedule repairing lanterns.

In addition to the lanterns repaired as above there have been 2,798 lanterns painted two coats, and 1,749 iron posts repainted one coat, during the year.

PUBLIC LAMPS.

The following table will show the increase of public lamps in eleven years:

Total increase in	1868	47
" "	1869	651
" "	1870	245
" "	1871	266
" "	1872	317
" "	1873	398
" "	1874	1,764
" "	1875	747
" "	1876	1,265
" "	1877	289
" "	1878	422
Total		6,411

The aggregate number of public lamps in the city of Boston is 12,069—an increase of 422 during the past year.

The petroleum oil (120 fire test) used for lighting the public lamps where gas is not in use, is purchased of the refiner, at the lowest market rate, and has fluctuated in price from 13 to 10 cents per gallon within the past year

The fonts from which it is burned are of a peculiar shape, adapted to the city use. These lamps give

good satisfaction where they are in use. The cost of maintenance of these lamps has not exceeded $15.75 each during the past year, including lighting and care, oil, fonts, chimneys, carting, wicking, etc.

PROPERTY OF THE DEPARTMENT.

In addition to the public lamps now located, and tools in the hands of the lighters, the department is possessed of the following property:

Six iron posts for stone sidewalks; 6 iron posts for bridges, with short bases; 2 iron posts for Federal street bridge; 2 iron posts for Common; 360 iron posts as used on the public streets; 147 lanterns; 369 new lantern frames; a small quantity of old iron, and 350 boxes of glass.

Four horses; 5 wagons (3 of them with racks for carrying lanterns); 3 pungs; tools for setting glass and repairing lanterns; and the necessary blankets, harness, and horse equipments.

Also, 2 horses; 2 harnesses; 1 top buggy; 1 open buggy; 1 sleigh; 1 buffalo robe; 2 wool robes; and the necessary stable and street blankets, kept for the exclusive use of the superintendent.

FINANCIAL CONDITION OF THE DEPARTMENT.

The balance of the appropriation on hand from 1877, on the 1st of January, 1878, was	$155,901 28
There was expended during the remainder of the financial year	143,204 56
The balance unexpended and transferred to other appropriations was	$12,696 72
The appropriation for the financial year ending on the 30th of April next was	$475,000 00
Amount expended to date	315,878 17
Balance unexpended	$159,121 83

An amount sufficient to meet all anticipated expenditures of the department for the remainder of the financial year, and allow of the transfer of $25,000 or more to other appropriations.

By the decline in the price of gas, oil, and other material, and the reduction of salaries, the expenses of the department have been reduced from time to time, until now the average annual cost of maintenance of each street lamp is less than prior to 1868, when the lamps were lighted and extinguished with reference to the hours when the moon was due to shine.

The great aggregate cost of supporting this department is to be traced directly to annexation, as one-half of all the street lamps are located within the annexed territory, and more than one-half the appropriation is expended outside the old city limits.

There are at the present time over 400 miles of streets and places lighted by this department, covering a more extended territory than any other similar department in the country.

The length of streets lighted in the old city limits in 1867 was not exceeding 85 miles.

The committee of the department, consisting of Aldermen Whiton, Faunce, and Spaulding, have generally supervised the purchase of materials used by the department, which have been procured with the advantages of the largest discounts.

Respectfully submitted,

GEO. H. ALLEN,
Supt. of Lamps.

The Electric Light in Paris.

Experiments which Show that Gas Light is Much Cheaper for the Same Amount of Illumination—The Report of M. Cernesson.

The lighting of large spaces by the electric light, especially in the experiments at Paris, has revealed some curious facts as regards the cheapness of this mode of illumination when compared with gas. The *Courrier des Etats Unis* published on Saturday an interesting article on the subject. The author of the article, M. Henri de Parville, takes as a basis the full and able report of M. Cernesson, which has been adopted by the Municipal Council of Paris, and which contains a very careful comparison of the expense of the electric light and gas light.

While it is certain, says the report, that the electric light furnishes the best illumination for large thoroughfares and public squares, it is not demonstrated that an equally brilliant illumination may not be obtained by using an increased quantity of gas, without incurring the amount of expense involved in lighting by electricity. It has not yet been proved that an economical light can be furnished by electricity. In view of this fact, the Municipal Council of Paris decided upon a series of comparative experiments by lighting the Avenue de l'Opéra, Place de l'Opéra, Place du Theatre Francais, and one large public interior, with electricity for a limited period. The Paris Gas Company at the same time uses a number of gas-burners of larger calibre than usual in certain thoroughfares and public places, and the results have been carefully registered and compared both as to the cost and the degree of illumination. Until M. Cernesson reported upon the question, the cost of the Jablochkoff light was a matter of conjecture, and it is of no little interest in settling the issue that the figures which have been obtained in Paris are accepted as correct, not only by the corps of city engineers and by the engineers of the gas company, but by the engineers of the Paris Electric Light Company. They are, therefore, incontestable.

The introduction of the electric light involves three sources of expenditure:—1st. A motive force to drive the rotary generator furnishing the currents; 2d. The electro-magnetic machine itself, and 3d. The electric lamp, or candle of Jablochkoff.

The engines employed are each of 20-horse power, driving Gramme generators. Each engine was found capable of running 16 Jablochkoff candles, or, in other words, each candle required for its successful operation a force equivalent to 1.25-horse power. Four engines and Gramme generators were necessary to the illumination of the Avenue de l'Opéra. The unit of illuminating power adopted was the light produced by a Carcel lamp consuming 42 grammes of pure oil per hour. It was first ascertained that 10 gas burners, using 140 litres of gas per hour, are equivalent to 11 Carcel lamps, while a single Jablochkoff candle is equal to 30 Carcels. But, as it was found necessary to the diffusion of the latter to shade it with an opaline globe, its illuminating power was practically considerably below this standard, being equal to only 18 or 20 Carcels when the horizontal rays were tested, and to only 10 or 12 when the oblique rays were under examination—a very meagre result indeed when compared with the actual light generated. The ultimate comparative result arrived at was that one Jablochkoff candle is practically equal to 11 gas jets of the ordinary calibre used for street illumination. But a comparison of the figures of cost showed that the amount of gas used might be so increased as to give an equivalent light without incurring a fully equivalent expense. When a burner consuming 200 litres of gas per hour was used, it required only 7 to equal one electric candle. Electricians hope to diminish the waste consequent upon the use of opaline globes, and M. Clemandot's invention—that of using two globes, the one fitting loosely into the other, and filling the space between the surfaces with powdered glass—has favorably impressed the scientific men of Paris. The particles of a thin layer of powdered glass appear to exercise a wonderful diffusive influence without materially reducing the illuminating power.

The cost per hour of running the 62 candles upon the Avenue de l'Opéra is thus stated by Levy, a competent engineer:

Motive force	3·20 francs.
Coal	6·64 "
Oil for lubrication	1·23 "
Cost of superintendence	3·20 "
Sixty-two candles	31·00 "
Total	45·27 francs.

A calculation upon this basis shows the cost per hour of running one Jablochkoff candle to be 73 centimes (about 14 1-3 cents). The electricians count upon a considerable reduction in the amount of motive force and cost of candles—enough, at least, to bring the cost per hour down to 60 centimes (about 11 4-5 cents). But, even upon this basis, the economical advantage rests manifestly with gas. In effect, then, while a Jablochkoff candle is equivalent to 11 gas burners of the Paris standard, these 11 gas burners cost only a little over 23 centimes per hour—something less than 5 cents. At the present figures, therefore, the relative expense of electric light to that of gas, illuminating power being equal, is as 73 to 23, and were the cost reduced to the limit urged by electric engineers as possible under existing circumstances, the proportion would still stand as 60 to 23, a very wide margin to be overcome. M. Cernesson's report further compares the questions of relative convenience, liability to get out of order, etc. Each electric lamp (*foyer*) being supplied with four candles, each burning 100 minutes, the whole provision has to be renewed every 7 hours, while with gas no such renewal is necessary. He finds that from May 30 to Oct. 10 there were 60 extinctions in all on the Avenue de l'Opéra, lasting from merely a minute or two to 15, 30, 35, and even 45 minutes.—*N. Y. Times, Feb.* 10.

Discharge of Sewage into the Sea.

BY HENRY ROBINSON, C. E.

A very general impression prevails that if a town is situated close to the sea it is necessarily in a more advantageous position than inland towns, respecting the disposal of its sewage, as it has only to avail itself of its proximity to the sea to get rid of its sewage by discharging into it. That this is an eroneous impression the experience of most of our watering places proves, and it is therefore desirable to offer a caution to those who are contemplating adopting a similar course.

In the Local Government Board Blue-book of 1876, one of the conclusions arrived at is as follows: That towns, situate on the sea-coast, or on tidal estuaries, may be allowed to turn sewage into the sea or estuary, below the line of low water, provided no nuisance is caused; and that such mode of getting rid of sewage may be allowed and justified on the score of economy."

This has been often quoted as encouraging the adoption of this method of sewage disposal, and it is to be regretted that the report gives no data whatever (such as are abundantly available) by which the qualifying expression, "provided no nuisance is caused," would be shown to apply to a great number, if not the majority of cases. It might have been stated that, to avoid a nuisance, the sewage must be discharged into the sea at a point not only below low water, but where there is a well-ascertained current which would carry it permanently seaward. A point of discharge complying with these conditions is but seldom found to exist close to the town, but has to be reached by long and costly outfall sewers, or rather tunnels. At the outfalls there should be a continuous movement seaward during the 24 hours, instead of an oscillating action to and fro, resulting in a return of the sewage and its deposition along the shore, not only at the outfall and in its immediate neighborhood, but also at distant places to which the tide carries. The writer has had occasion to inspect many watering places where the foreshore is being distinctly polluted in this way. At first the mischief is not great, and only traces of the sewage are visible; but in time it becomes serious, and the knowledge of of the existence of sewage pollution on the foreshore causes the places to be avoided by those who hitherto have resorted to it. The grievance is not a merely sentimental one, as the exhalations along the foreshore from sewage accretions at low tide involve not only offensive smells, but also a danger to health.

The difficulties attending the discharge of sewag into the sea would be diminished were it not that it has a higher temperature and a lower specific gravity than the sea or river water, which causes it to rise to the surface; and if it is not carried seaward at once, part of the suspended solid impurities are deposited on the coast wherever there is still water and no tidal current, whilst the rest of the suspended, together with the dissolved, impurities float on the surface, and are carried backward and forward by every tide, decomposing and liberating gases (sulphuretted hydrogen being one of the most offensive) injurious to health and polluting the air.

In some cases, by means of long outfall sewers, the sewage is carried clear away from the place producing t, as at Brighton. These practically become elongated cesspools, in which noxious gases are generated, and are liable to be forced back into the town drains, and thence into the houses. In these long outfalls, also, the solids deposit, and involve both expense and difficulty to remove. Even if the places producing the sewage really get rid of it in this way, they are frequently simply transferring it to others, a set of the tide carrying it so as to cause mischief and nuisance elsewhere.

No better illustration of this can be given than the experience of Margate. The authorities there proproposed, after much competition amongst rival engineers, to adopt a scheme by which the sewage was to be discharged into the sea, in a bay about a mile and a half eastward of the town, where it turned out that there was practically no current seaward, so that, had the scheme been carried out, the coast there would have been permanently polluted, as the sewage would have risen and dropped with the tide, evolving all kinds of dangerous and offensive gases, which would have effectually driven visitors away, and have depreciated to a serious extent the value of the neighboring property.

Ramsgate is in a similar difficulty, and many other places could be cited where it is a matter of serious concern how to deal with the sewage. The authorities are compelled to drain their towns, and the very effort they make to comply with the sanitary requirements of the day appears to involve them in almost greater difficulties. There is only one way of safely dealing with sewage at seaside places where the tidal currents are not clearly favorable, and that is to deodorize the sewage before it is discharged into the sea.

The authorities of Glasgow have had the question of how to get rid of their sewage under consideration for a long while. A royal commission investigated this case, and although the result of this was to advise the adoption of a scheme to carry the sewage twenty-seven miles in a tunnel to the sea, at enormous cost, and although this advice was similar to that previously given, the authorities took the matter into their own hands, and appointed a committee of their body, which has since presented an exceedingly able and interesting report, giving the results of their investigations. The conclusion they arrive at is not to adopt the recommendations to discharge their sewage into the sea, but to discharge it into the river Clyde, after it has been purified by chemical treatment.

Where there is a risk of nuisance, either to the place to be drained or to its neighbors (which is equally important), by discharging sewage into the sea, a clarification and deodorization of the sewage can be easily and cheaply effected. No attempt to arrest the solids in catchment tanks can possibly be satisfactory, inasmuch as they only remove a very small portion of the solids, and become hugh cesspools, which have to be cleared out at intervals, with a certainty of causing great nuisance. Filtration also is not admissable, as the filters soon get inoperative, and become in addition as great a nuisance as catchment tanks. By deodorizing the sewage the first difficulty is overcome, as the sewage is no longer offensive.

There has hitherto been much prejudice against chemical treatment, which is, however, disappearing, as it has been abundantly proved that sewage can thereby be deprived of its offensive properties by simple and inexpensive means. The disposal of the semi-fluid sludge has been a difficulty which the writer has had to give much attention to, and he has employed several methods of converting it into a portable form. The plan which he has found the best is to remove a great part of the moisture from the sludge, by means of a simple filter press. A model of this press (which is an automatic modification of an old construction of press) has been placed in the Exhibition of Sanitary Appliances. By an appliance of this kind, the sludge has the bulk of its water pressed out, and the consequent reduction, both in mass and consistency, enables the sludge to be better removed and utilized, or dealt with in any other way.—*Journal of the Society of Arts.*

Drainage of an Apartment House.

The *Plumber and Sanitary Engineer*, for February, gives a full page illustration showing how this ought to be done, which is described as follows:

"The arrangement of drain pipes in an apartment house are substantially the same as shown in illustration of a city dwelling on page 20, January number of last year.

"Beginning with the street front the double trap is placed on the main soil pipe as a security against back pressure from the sewer during a storm or high wind. These traps are placed at a point where they can be readily examined and cleaned. The vent shaft up the front wall is placed *within* the first of these traps, as it is not advisable to ventilate the sewer directly, particularly if there are adjoining houses with windows at a greater height than the top of the vent pipe, in which case any foul air would be wafted into them on occasions, and prove a nuisance.

A fresh air or ventilating shaft, ends at an opening at the curb, having an open iron cover; it is also intended as a vent for gas when a column of water or solid matter is coming down the main pipes and precludes the possibility of the traps up-stairs being forced by back pressure.

The vent shaft up the front wall should be four inches in diameter. Should the outer trap be forced by back pressure—a contingency possible in many cities—it is supposed the sewer gas could find exit up this shaft easier than to force the second trap.

"There is a two-inch waste pipe, into which empties the wash basins. Each trap under wash basin should be ventilated by a pipe, extending to roof. If the trap is 1½ inches, this vent pipe should be not less than one inch, and larger if the basins are located a distance from a point where the vent reaches the fresh air. Some authorities claim that the vent shonld be the same size as the area of the trap.*

"It will be noticed that the basins and baths empty into a 3-inch waste-pipe. The same rule should be observed in ventilating the traps as that given above.

If the rain water pipe were filled by the passing down of a column of water, or choked up, and both of the main waste-pipes were in use passing down matter, the advantage of the vent-pipe to the curb would be seen; and its outlet being at the curb, no offensive smell could enter the house. It will be noticed the main house waste passes along the cellar wall, where any defect or leakage could be easily discovered, and not, as in many cases, under the cellar bottom, which should never be allowed.

"In the system of drain pipes shown there are five unobstructed communications with the outer air. In these circulation would be kept up that would prevent the retention for any period of foul air within the house drains.

"Cast iron pipe and fittings of proper weight, free from sand holes, should be used, and should be coated with coal tar, inside and out. Joints should be calked with oakum and molten lead, and all lead connections to branches should be by brass ferules calked in a similar manner.

"If this plan and these instructions are carried out a house would, in our judgment, be practically safe from sewer gases.

*—The vent from trap should be as nearly the same size as the trap as is practicable. Half the size will do in some places, but will hardly do where the outer air is several stories away from the trap.

"As this is an important question, Mr. E. S. Philbrick proposes to furnish us with the results of some experiments and his views on the matter."

OUR EXCHANGES.

United States.

[*Engineering News.*]

The Tecumseh (Mich.) water works were frozen up during the recent "cold snap." No water could be obtained from the pipes.

The West Chester (Pa.) Gas Company has reduced the price of gas to $2.80 per thousand, and the Bristol (Pa.) Gas Company to $3 per thousand.

A break in the main of the Pittsburgh (Pa.) Gas Company on the evening of Jan. 9 caused sudden darkness to fall upon most of that city, to the no small consternation of pleasure-seekers, public officers, and actors.

S. A. Beers & Co., of this city, have asked of the city of New Britain, Conn., permission to lay gas pipes through the streets, and have agreed, if the permission is granted, to furnish gas for each street lamp, until midnight each night, for 10 cents, and to furnish gas all night for 14 cents.

The work of replacing the gas lanterns with oil lanterns, in pursuance of the contract recently made for lighting the streets of Columbus, O., with oil, is progressing slowly, and in the meantime the city depends on the moon for steady light a part of the night, and is in darkness the remainder.

The Circleville (O.) Gas Company has reduced the price to $2.75. Their friends advised a reduction of $2.50, but it wasn't made. Meanwhile, during cold weather, the quality of gas is execrable, and the quantity burnable greatly reduced by freezing of pipes, so that many of the merchants use oil in their stores.

The Senate of Minnesota, on Jan. 8, ordered the appointment of a special committee on Drive-Wells, with reference to the proceedings of patentees who are endeavoring to collect an excessive royalty from thousands in this State who have used these wells for years, having paid for them to former claimants of the patent.

The Cincinnati *Enquirer* of Sunday says: "We are informed that the Edison Electric Light Co. of New York City recently made a proposition to the Cincinnati Gas-Light and Coke Co., offering to sell them the exclusive use of the 'light' for Hamilton County for $40,000. Gen. Hickenlooper, president of the Gas Company, promptly refused the offer. He has more faith in coal than in electricity."

Capt. Jas. B. Eads has prepared a plan for the reclamation of the Potomac river-front, and the improvement of the sewerage of Washington.

Darkness of Caverns.—The fact that the light of torches does not diffuse itself in a cavern is ascribed to the presence of a mouldiness which covers their roofs and sides, and absorbs all those floating particles of dust which would otherwise act as reflectors.—*Les Mondes.*

TRADE MARK.

THE FUEL OF THE FUTURE!

GAS!

THE "SUN-DIAL" GAS COOKING STOVE.

WM. W. GOODWIN & CO.,

SOLE AND ONLY MANUFACTURERS

1012, 1014, 1016 Filbert Street, Philadelphia,

And 142 Chambers St., New York.

GAS STOVES

FOR

Cooking and Heating Purposes.

We have added to our manufactory a Gas Stove Department. We are prepared to execute orders for Stoves to cook for one or one hundred persons; also Gas Heating Stoves of all sizes.

If Gas Companies will give this Department attention and encouragement, their consumption can be largely increased.

The Paris Gas Company (France), through attention to this subject, have largely increased their day consumption, equaling 42 per cent. of the entire amount consumed the past year, by the use of gas for Gas Stoves and Gas Engines.

In presenting our Gas Stoves to the public for their favorable consideration, we claim the following as some of the advantages in comparison with coal and the ordinary gas stoves heretofore used.

1st. More healthful, through the absence of waste of heat, soot, smoke, dust and smell.

TRADE MARK.

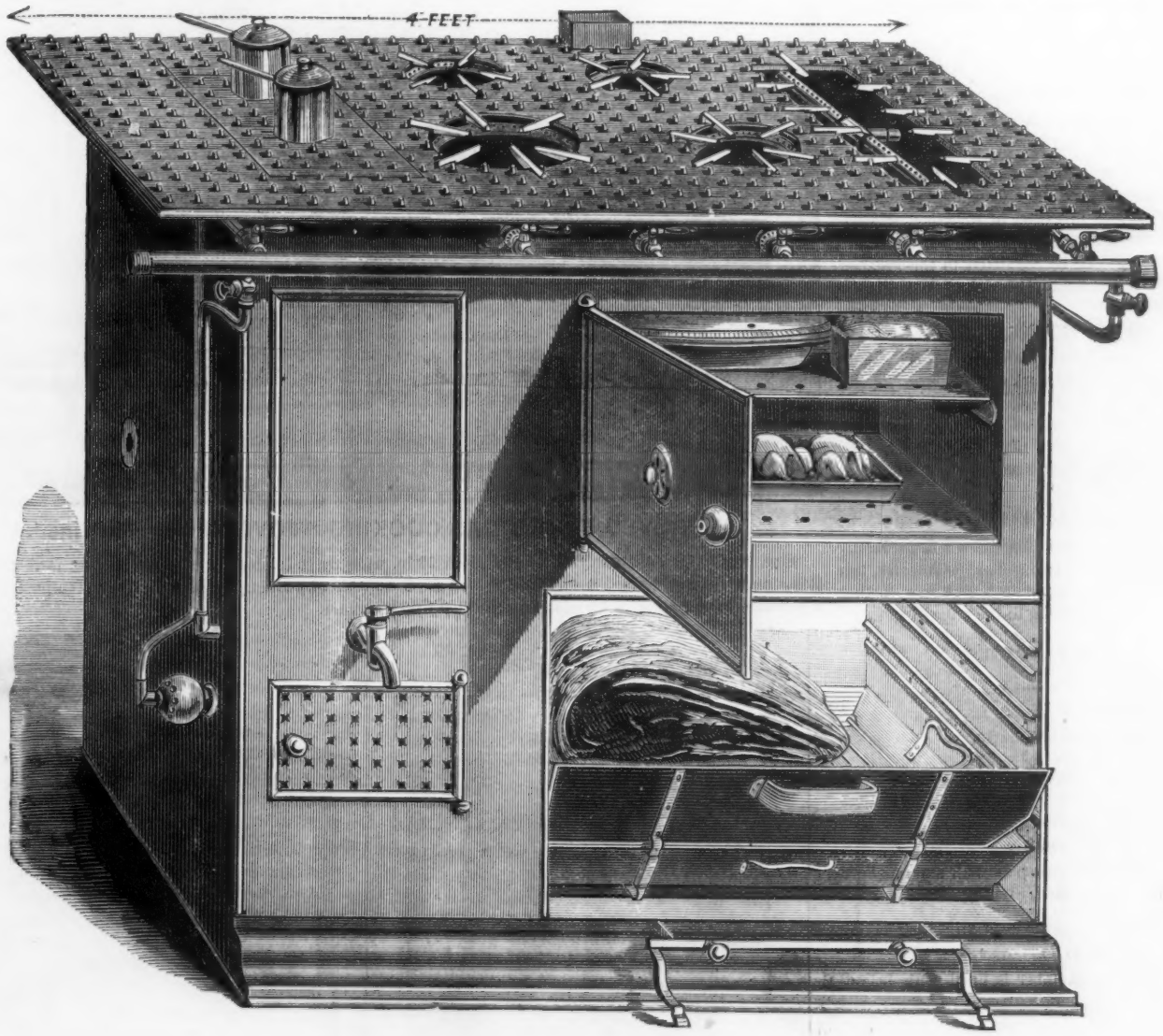
2nd. More certain, by the rapidity of manipulation, in consequence of the simplicity of construction.

3d. Less troublesome, requiring very little attention during the process of cooking.

4th. Less expensive.

5th. Less wasteful, through loss of weight. The juices and fat instead of being separated, as is the case in ordinary process, remain thoroughly incorporated with the meat, a point of great importance in a nutritive as well as in an economical sense.

6th. The adoption of the most perfect burners in all the apparatus, whether for heating or cooking purposes, discovered by scientific research.



HOTEL GAS COOKING STOVE, No. 12.

Size, 39 in. high, 40 in. wide, 21 in. deep. Hot-plate, 48 in. wide, 24 in. deep, with bright rail.

This stove is specially adapted for hotel use, having a 24 in. Roasting Chamber, lined with tin plates, the burner being divided in the centre, only half the gas can be used, if required for small joints.

The Oven, which is heated by the waste heat from the roaster burner, is 18 in. deep by 20 in. wide, for baking pastry, &c.

The Boiler, which will hold about eight gallons, is made of copper (tinned inside), with copper lid, brass draw-off tap, and separate burner.

An Iron Cover, with two holes for receiving small sauce-pots, is supplied with each Stove, also two extra pans, one for grilling and toasting, the other for cooking fish.

A sliding tray is placed under the hot-plate burners for removing dirt, &c.

A movable copper reflector for radiating the heat into the room.

This Stove is also made without boiler. 39 in. high, 46 in. wide, 21 in. deep, with one 24 in. and one 22 in. Roasting Chamber (tin lined), with oven over same. Hot-plate, 48 in. wide, 24 in. deep, with five single burners and two double burners.

THE "SUN-DIAL" GAS COOKING STOVE.

These Stoves are constructed especially to meet the requirements of domestic economy.

Economical and inexpensive cooking is obtained by the simple method of utilizing every particle of heat derived from the gas.

Departing from the old system of gas cooking, which was open to many grave objections, the gas-burner is placed ABOVE the joint and not under; over this burner is fixed a radiating metal plate to reflect the heat; the same burner, being above the joint and beneath the Oven, answers both for the purpose of Roasting and Baking at the same time. By another simple contrivance of surrounding the Oven with a case or jacket, the heat is thereby increased, the combustion is rendered complete, and also serves another important purpose in causing a regular distribution of heat all over the Oven. The most limited experience proves that in all the stoves now in use the Oven is always hottest in that part nearest to the fire; consequently, it is a common occurrence for food in an ordinary Oven to be raw in one part and burnt in another. This is prevented by the hot air surrounding the Oven.

THE ONLY GAS STOVE BY WHICH JOINTS AND POULTRY CAN BE ROASTED AS BEFORE AN OPEN COAL FIRE.

These Stoves are so arranged that a family dinner can be cooked without the aid of any other appliance. The various processes of Roasting, Baking, Boiling, Grilling or Toasting can all be carried on, and each process can be regulated to the greatest nicety by the adjustments with which each Stove is fitted.

These Stoves have been submitted to every possible test, and can be therefore confidently recommended as doing all the work of a Kitchen Range, in a more cleanly, economic, certain and efficient manner; and no one, unless previously informed, would have the least idea that Joints Roasted by these Reflecting Gas Stoves were not cooked before a coal fire.

The following can be cooked by the Stove No. 8:

A joint weighing 10 or 12 pounds, a large family pie, a couple of ducks, two sorts of vegetables, fish and soup, consuming about 40 feet of gas, costing from 8 to 12 cts., according to the price of gas.

ADVANTAGES.

1. An open Roaster.
2. Free from all contact with gas.
3. A well-ventilated Oven.
4. No confined vapor.
5. A regular diffused heat.
6. A Griller free from smoke.
7. A Hot-plate fitted with patent air and gas burners, arranged for Boiling, Stewing and Frying.

THIS STOVE IS FITTED WITH THE FOLLOWING RECENT IMPROVEMENTS:

1st. The Roasting chamber is lined with bright tin plate.

2d. The Roasting burner is divided in the centre, with tap at each side, so that small Joints, Chops, etc., can be cooked at a small cost.

3d. A bright tin angle-plate is supplied for placing on the gridiron when only half the burner is in use.

4th. A movable iron trivet, for supporting the pan at various heights, to facilitate turning the Joint and basting.

5th. An elbow burner, with separate tap, is inserted in centre of large ring burner, for simmering purposes.

IMPROVED FAMILY GAS COOKING STOVE, No. 8.—Tin Lined.

Size, 36 in. high and 18 in. wide. Hot-plate, 22 in. wide by 16 in. deep, with three burners for boiling. For Roasting, Grilling, Baking, Boiling and Toasting. Is capable of cooking a dinner for five to ten persons. With a movable copper reflector for radiating the heat into the room.

GAS COOKING STOVE, No. 5.

Size, 22 in. high, 12 in. wide, 11 in. deep, with Oven.

Will roast a fowl or small joint, grill chops, steak or bacon, toast bread, make pastry, boil, fry or stew. Movable copper reflector for radiating the heat into the room.

GAS COOKING STOVE, No. 6.

With front tin reflector to pan.

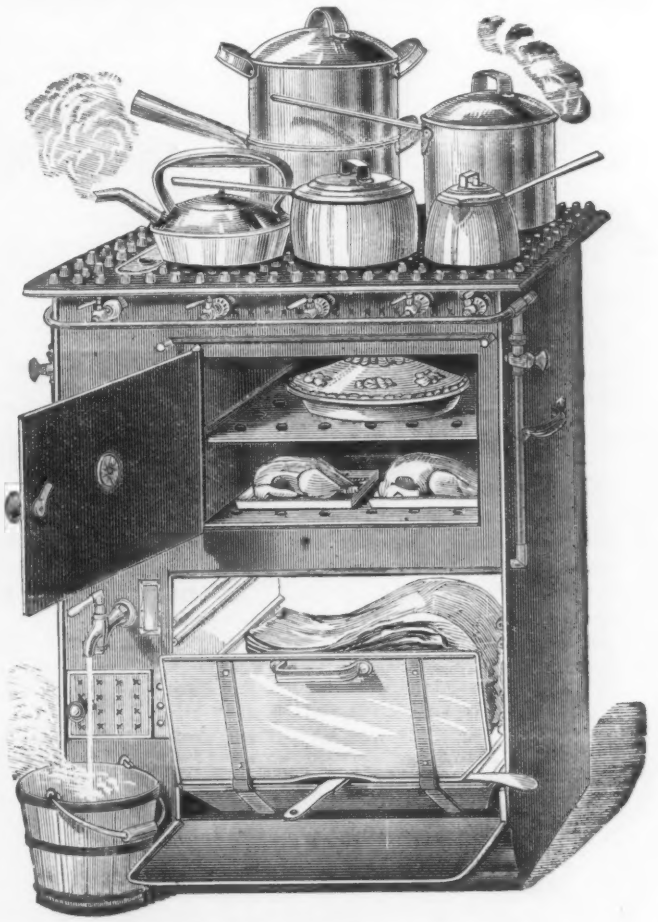
Size, 19½ in. high, 15 in. wide, 12½ in. deep. Hot-plate, 18 in. wide, 15 in. deep, with two air and gas-ring burners. It has tin-lined roaster, extra elbow-burner to hot-plate and movable trivet. It has a movable copper reflector for radiating the heat into the room.

IMPROVED GAS COOKING STOVE, No. 7.

Size, 30. in high, 15 in. wide, 12½ in. deep. Hot-plate 18 in. wide, 15 in. deep, with one oval and one ring burner, with sliding tray under hot-plate.

Will roast a joint 7 lbs., couple of fowls, grill chops, steaks, bacon and fish, toast bread, bake pastry, rice puddings, potatoes, &c., boil, fry, or stew. Movable copper reflector, for radiating the heat into the room.

The roasting chamber of this Stove, is lined with bright tin plate, and is fitted with a movable trivet for supporting the pan at various heights, an elbow burner is also inserted in the hot-plate with a separate tap.



COMPLETE GAS COOKING STOVE, No. 9.

With Copper Boiler.

35 in. high, 24½ in. wide. Hot-plate 28 in. wide, 16½ in. deep, with 2 single and 1 double burner, 4 taps, with tray underneath for removing dirt, &c. Roaster, 18 in. wide, 12 in. deep, 13 in. high, with burner divided in centre, 2 taps. Oven, 15 in. wide, 11 in. deep, 9½ in. high, with double jacket or casing for retaining the heat. The Tinned Copper Boiler, with brass draw-off taps, holds about 2 gallons, and is heated by an atmospheric burner with separate tap at side.

COMPLETE GAS COOKING STOVE, No. 11.

With Copper Boiler.

Size, 35½ in. high by 18 in. deep. Hot-plate, 31½ in. by 19¾ in., with bright rail.

The hot-plate has five air and gas burners with tap to each burner, with sliding tray for removing dirt, &c. The burner for roaster has two taps, and is divided in the middle, so that only half the amount of gas may be used when required. The Roaster, is 20 in. wide, and is lined sides and back with tin plates, and with movable trivet. The boiler is copper (tinned inside), about 23 in. deep, with copper lid, and has a separate air and gas burner.

This Stove is arranged for roasting (as before an open fire), grilling or toasting (under the gas), baking, boiling, stewing, or frying, and is capable of cooking a dinner for five to twenty persons.

It has a movable copper reflector for radiating the heat into the room.

Gas Cooking Stove, No. 0.

With improved movable slide over burner, which, when drawn out, causes a much greater heat under the kettle. 7 in. wide, 7½ in high, 9 in. deep. With front tin reflector to pan.

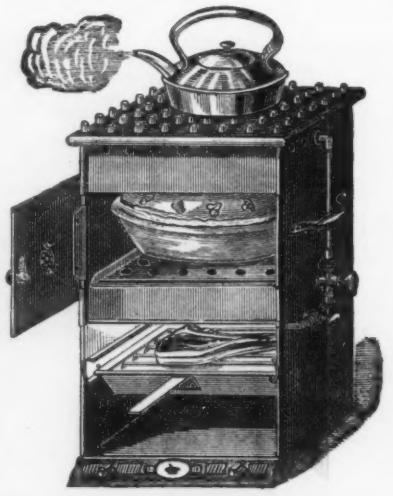
Will grill a steak, chops, bacon or fish, toast bread, boil water, stew or fry with one burner only. 3 ft. of gas (at a cost of less than one cent) will grill a chop and boil a pint of water.

Gas Cooking Stove, No. 3.

With front tin reflector to pan.

Size, 16 in. high, 12 in. wide, 11 in. deep, with burner for boiling.

Will roast a fowl, grill chops, steaks, bacon, etc., toast bread, boil water, stew and fry. Movable copper reflector for radiating the heat into the room.

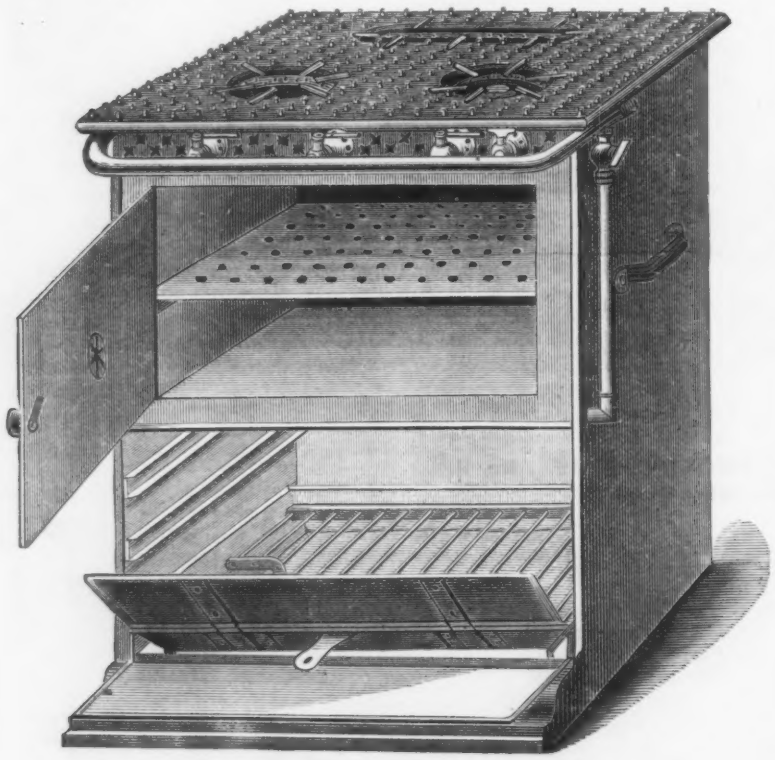


Gas Cooking Stove, with Oven, No. 4.

With front tin reflector to pan.

Size, 9¼ in wide, 16½ in. high, 7 in. deep.

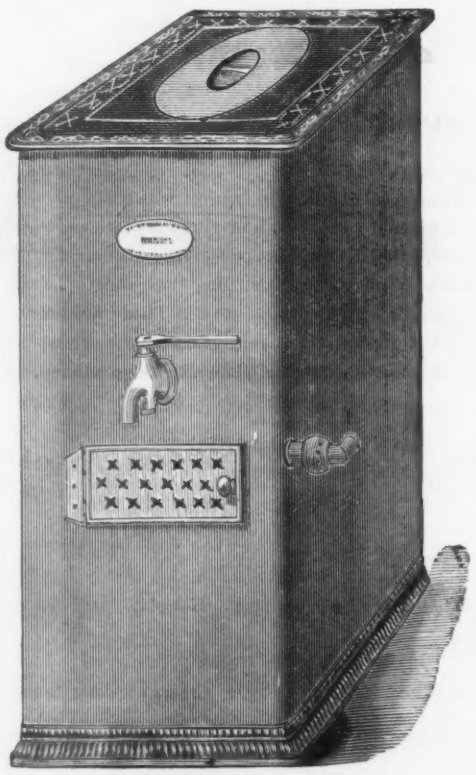
For roasting, grilling, baking and boiling. With movable copper reflector.



GAS COOKING STOVE, No. 10.

Size, 35 in. high by 22 in. wide. Hot-plate, 26 in. wide and 23 in. deep, with bright rail.

The hot-plate has two round air and gas burners, with centre burner to each, and a straight air and gas burner for fish kettle, and sliding tray for removing dirt, etc. The burner for roaster is divided in the middle, so that only half the amount of gas may be used when required. The roaster is 22 in. wide, and is lined with tin plates, and a movable tin reflector is fixed in front of the dripping pan, with movable trivet. This Stove is arranged for roasting, grilling, baking, boiling, frying and stewing, and is capable of cooking a dinner for 15 to 30 persons. With a movable copper reflector for radiating the heat into the room.



GAS HOT-WATER CISTERN, No. 53.

35 in. high, with air and gas burner, and brass door. The Boiler holds about 5 gallons of water. This Boiler is also made to hold about 8 gallons of water.

These Boilers are especially adapted for placing by the side of the gas cooking stoves, and are also strongly recommended for general use in stables, workrooms, factories, etc., or where a large quantity of boiling water is frequently required.

WM. W. GOODWIN & CO.,

SOLE AND ONLY MANUFACTURERS,

1012, 1014 & 1016 Filbert St., Phila., and 142 Chambers St., N. Y.

Electric Lighting.

In reviewing the present state of electric lighting, the *Journal fur Gasbeleuchtung*, etc., says:

Its practical utility as an illuminating agent has only been acknowledged since means have been discovered, 1st, to generate the current at a relatively low cost; 2d, to produce an almost constant light; 3d, to subdivide the light.

The first decisive step towards giving the electric light its present undeniable importance, was the substitution of the magneto-electric and dynamo-electric machines for galvanic batteries.

Owing to the more rapid and irregular wasting of the positive carbon pencil, different mechanical arrangements were designed to keep the points at a constant distance from each other. Serrin's lamp has been principally used, till last year, when Jablochkoff gave a new complexion to the whole subject by his invention. He places the carbons beside each other, and isolates them with a mass, solid at ordinary temperatures, but fusing at such as are necessary for the production of the voltaic arc, and becoming then a good conductor. Powdered glass and kaolin have been used for this purpose, but lately other preparations have been substituted, partly to render the color of the light more agreeable, partly to obtain greater steadiness.

This property of the isolating mass enables the current to be subdivided. Besides, the improved machines can also generate several currents, so that each may be used to operate several lamps. For instance; the 48 lamps which illuminate the Avenue and Place de l'Opera, Paris, are operated by three machines, each furnishing four independent currents, and each of the latter feeding a group of four lamps. Each lamp has four carbon candles on a turn-table, so that when one wastes away (in about 1½ hours, the machine working uniformly) a new one can be placed in position by turning a crank. The whole arrangement is enclosed by thick ground glass. To ignite the carbon, a piece is laid on top, which is rapidly consumed.

The copper wires from the machines are covered with gutta percha, carried underground through earthenware pipes, and isolated every half-metre by the supports. Four wires run from each of these main wires to each of the four carbon pencils of a lamp; the current then is led by a single wire to the next lamp, then to the third, to the fourth, and finally back to the machine.

The lamps operate six hours, when gas is substituted. At least one horse-power is regarded as necessary to operate a lamp. Its intensity is considered as equal to that of 100 gas-jets (each consuming 105 litres per hour). But this is only partly true, as the gas-flames must be regarded as concentrated at one point. If a given enclosure is illuminated by a number of gas-jets, and then by the electric lamp, the latter cannot replace more than 30 jets; generally less—between 20 and 30.

A great advantage is the almost complete immunity from danger of fire and the small quantity of heat evolved.

The city of Paris pays 1 fr. 45 c. per hour for each lamp, which nominally gives a light of an intensity of 100 gas-jets. The scientific journals, however, state that the real intensity is equal to no more than 20 jets, with a total consumption of 2·8 cubic metres per hour.

Further taking into account that two main wires must be laid to each lamp, with four branch wires; that every 1½ hours a new carbon candle must be brought into position by hand; further, that one machine, requiring one horse-power, is needed for every four lamps, and cannot be placed at one centre with others, as it is impracticable; and finally, the unreliable nature of the steam motive-power which generates the light; no one will seriously think that street lighting can at present be accomplished.

For lighthouses, large open squares, workshops, depots, theatres, and large halls, it may be adapted, and in those cases it will compete with gas.—*Jour. Frank. Inst.*

Election of Officers of Montgomery Gas Light Company.—At the regular annual meeting of the Stockholders of the Montgomery Gas Light Company, held on the 6th inst., the following officers were unanimously elected for the year 1879: Pres., Chas. T. Pollard; Directors—B. S. Bibb, John Gano Winter, David Clopton, J. S. Winter, E. G. Fowler. Col. John Gano Winter, for many years president of the Company, declining a re-election, the following resolution was unanimously adopted: "Resolved, That we part with our president with regret, and acknowledge our obligations for his faithful and efficient services to the company during the long period of his connection with the company as its chief officer." The Directors then re-elected the following officers: Sec. and Treas., T. Gardner Foster; Supt., James Somerville.

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
(with W B Scott & Co.,)

24 Pine street, New York City.

February 17, 1879.

☞ All communciations will receive particular attention
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid.	Asked.
Gas Co.'s of N. Y. City.				
Central	466,000	50	60	75
Harlem	1,800,000	50	30	50
" Bonds	170,000			103
Manhattan	4,000,000	50	170	175
Metropolitan	2,500,000	100	120	125
" Scrip	$1,000,000	..	95	100
Mutual	5,000,000	100	65	70
" Bonds, gold	900,000	1000	95	99
Municipal	1,500,000	100	105	115
" Bonds	750,000		95	100
New York	4,000,000	100	90	95
Nothern	270,000	50	—	100
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	130	135
Citizens	1,200,000	20	60	70
" Scrip	320,000	1000	90	95
Peoples	1,000,000	10	20	30
" Bonds	325,000	...	--	95
" Scrip	300,000	...	75	80
Metropolitan	1,000,000	100	60	65
Nassau	1,000,000	25	50	56
" Ctfs.	700,000	1000	—	90
Williamsburgh	1,000,000	50	80	85
" Scrip		...	88	92
Kings Co	200,000	100	—	70
Union Co. E N. Y.		25	—	50
Richmond Co., S. I.	300,000	...	60	85
Out of Town Gas Companies.				
Bath, Maine	70,000	100		
Buffalo Mutual, N.Y	750,000	100	65	70
" Bonds	200,000	1000	95	100
Baltimore, Md.	2,000,000	100	95	98
" Ctfs., gold	1,000,000		95	10
Bayonne, N. J.		100		90
Brockport, N. Y.	25,000	100	...	80
Citizens, Newark	918,000	50	90	95
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			128	13
Cincinnati G. & C. Co.				190
Derby of Conn	160,000	100	60	80
East Boston, Mass		25	114	120
Elizabethtown, N. J.	300,000	20	—	130
Fort Wayne, Ind.		100	...	—
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	120	125
Hempstead, L. I.	25,000	100	...	—
Jersey City	386,000	20	140	145
Jamaica, L. I.	25,000	100	...	—
Jacksonville, Ill	120,000	50	82	...
Lewistown Maine	400,000	100	70	80
Lima, Ohio,	60,000	100	—	...
Bonds	30,000		90	
Laclede St Louis Mo.	1,200,000	100	—	75
Long Branch		20	30	40
New Haven, Conn		25	136	152
Peoples, Jersey City		...	—	80
" Bds.				95
Peoples of Albany	650,000	100	10	17
" Bonds	350,000	1000	--	-
Peoples of Baltimore		25	44	48
" Bonds			106	—
Plainfield, N J	80,000	100	—	105
Perth Amboy		25	—	95
Rochester, N. Y.		100	50	60
Toledo, Ohio			95	97
Washington, D. C.		20	—	200
Yonkers		50	70	80

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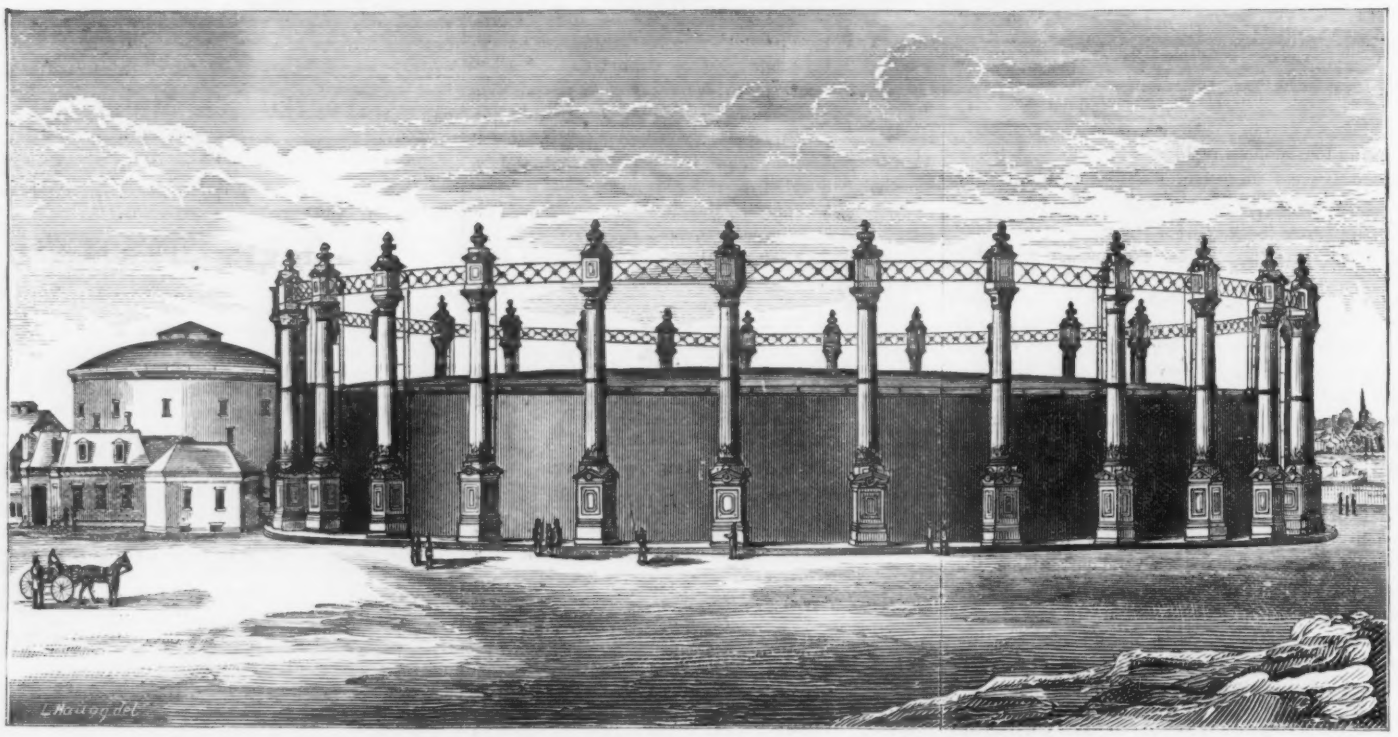

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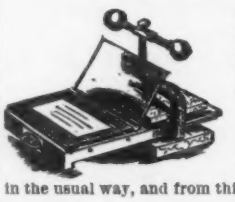

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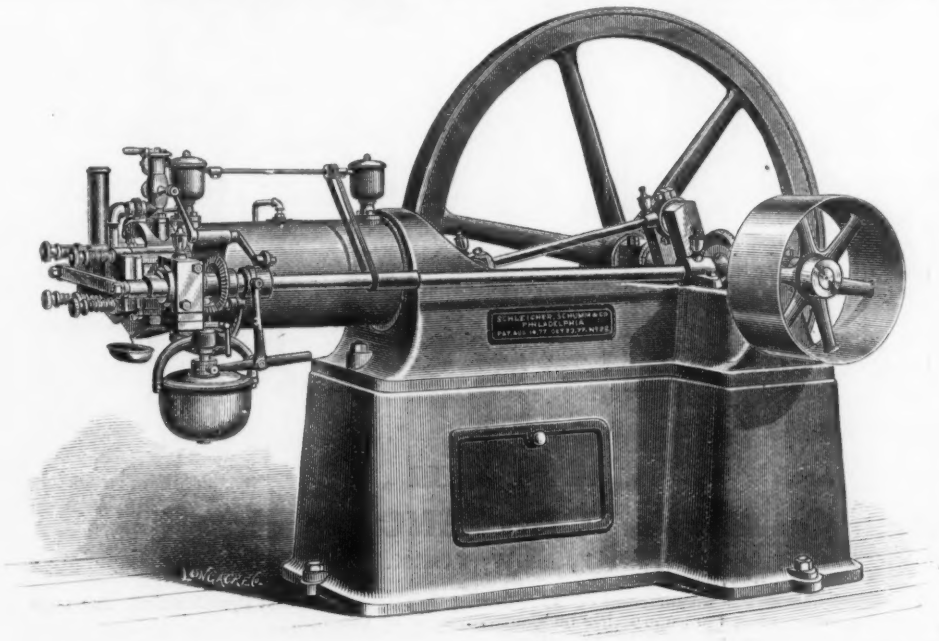

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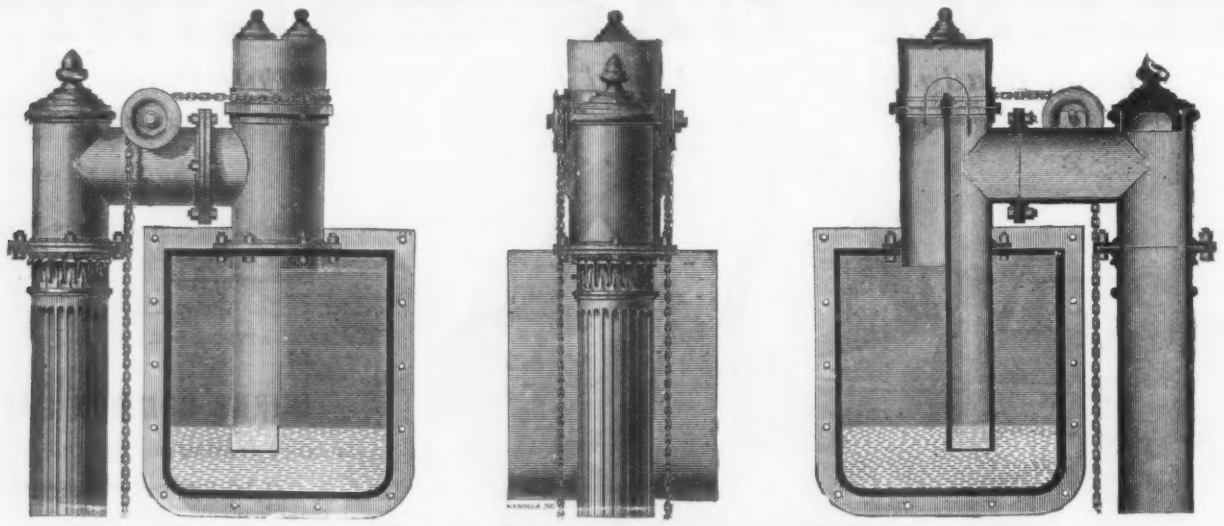

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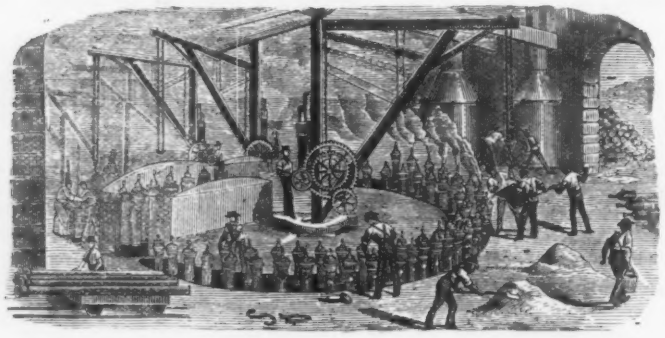

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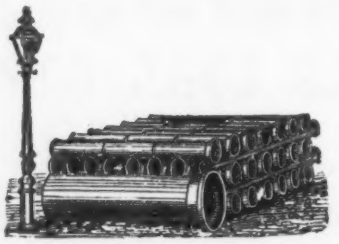

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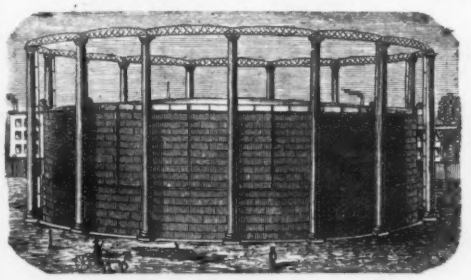

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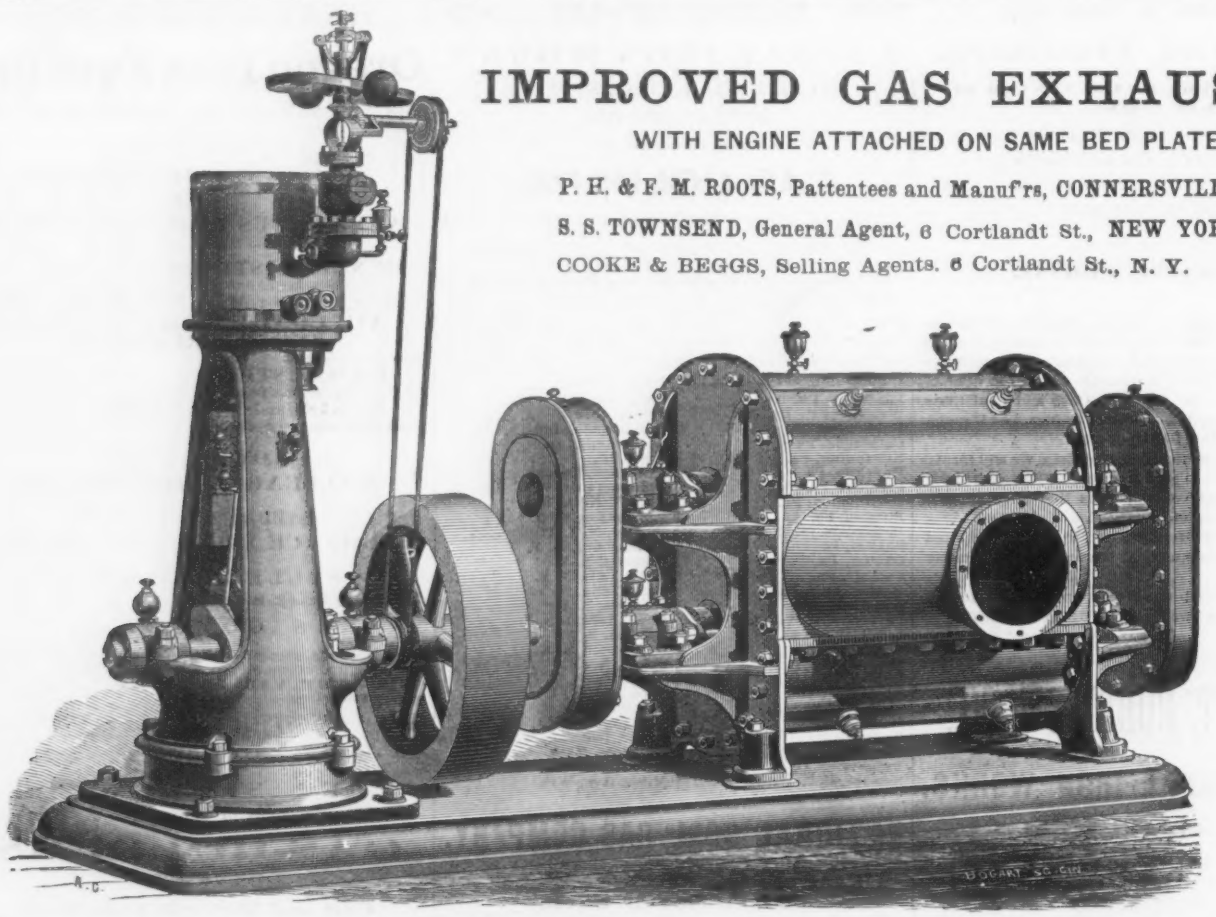

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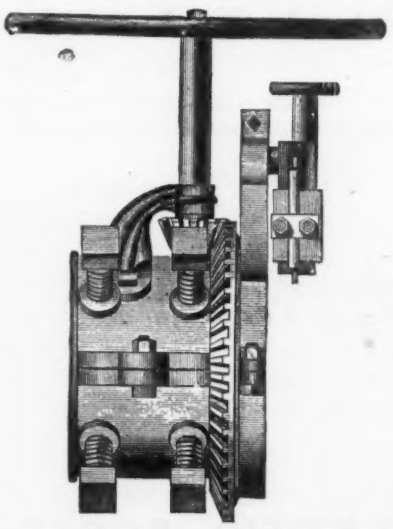

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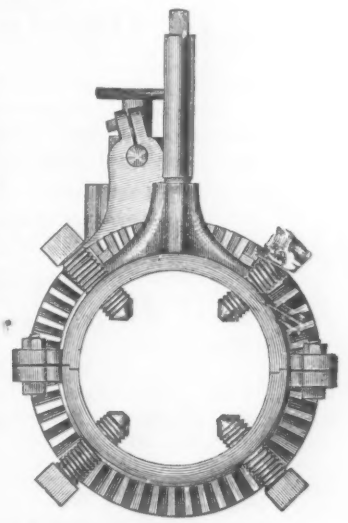

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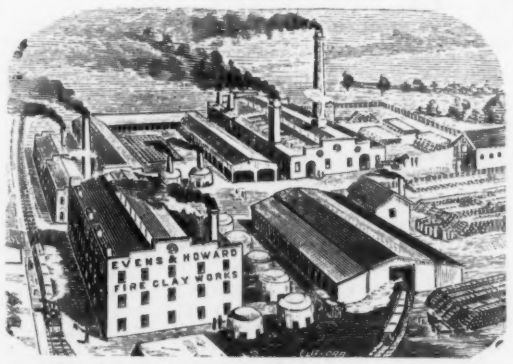

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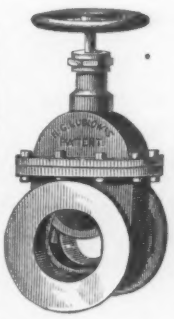

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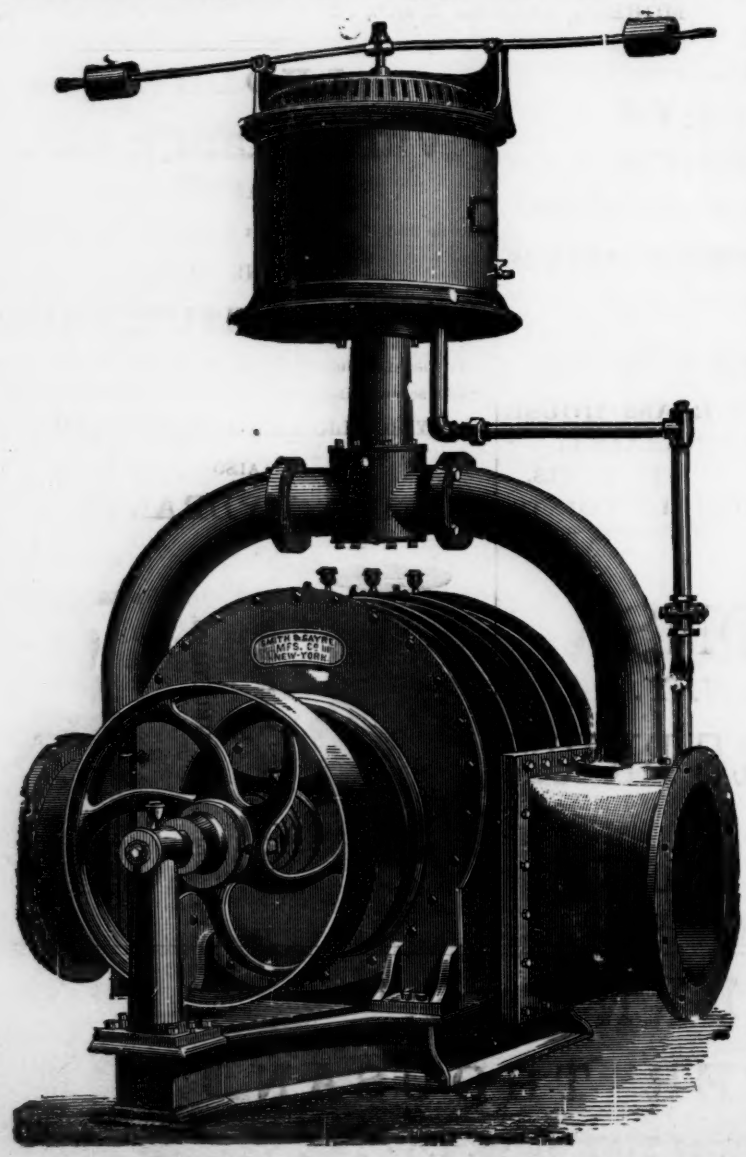

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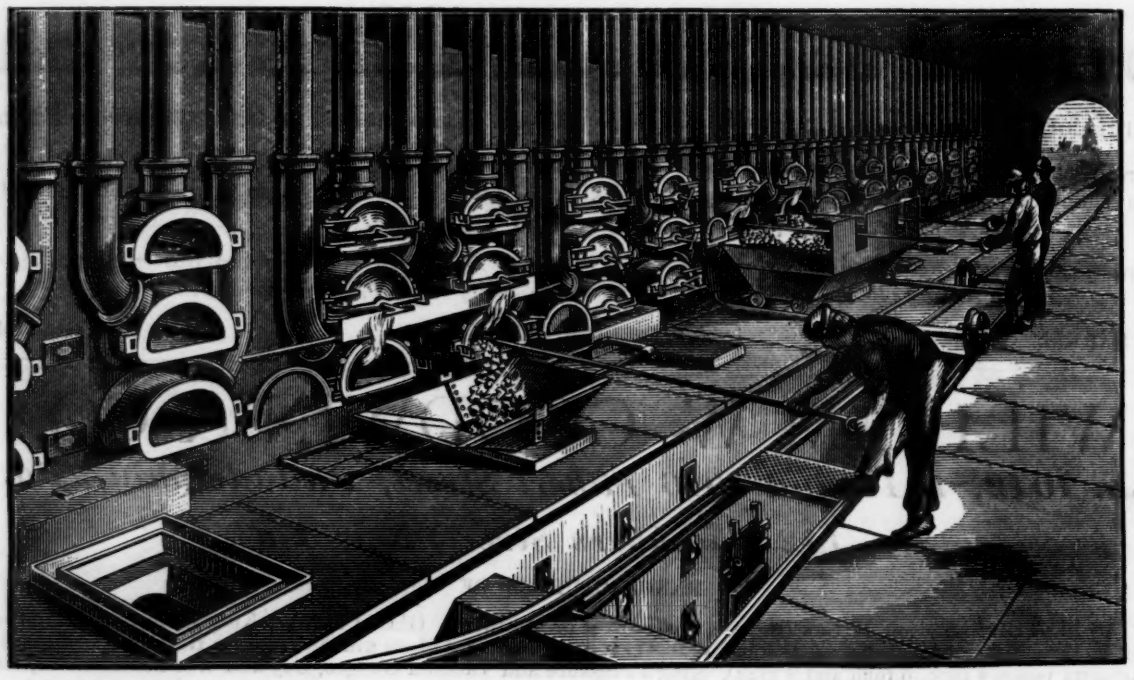

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